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THE WORKING OF A LABOR DEPARTMENT IN INDUSTRIAL ESTABLISHMENTS.

By C. U. Carpenter.

Widespread and serious labor troubles, recent and current, and on both sides of the Atlantic, point out the critical importance of Mr. Carpenter's theme. It needs no more than the report of the "Coal-Strike Commission" to establish the truth of his central proposition—*"the time to stop trouble is before it begins."* And the need of definite, organized attention to putting this principle into practice exists in every works which has grown beyond the point where the manager can be in personal touch with every workman. The means for doing this successfully must be more complex in a large establishment, but the conception is universally applicable. Further reference to the matter is made in our Editorial Comment on page 99.—THE EDITORS.

THE "Labor Problem" now confronting us cannot be solved until the same principles of organization that have been such great factors in commercial success are brought to bear upon it. Manufacturers generally, though they have recognized the seriousness of the situation for some time, are just beginning to realize the necessity for a general and comprehensive plan of organization. Practical experience has already proven the great value of strongly organized bodies of employers to meet and bargain with the existing organizations of labor. Experience also shows that these organizations of labor will themselves be benefitted ultimately by the existence of such a bodies of employers.

It is my purpose not to dwell upon the value of such organizations, but to bring out the great benefits to be derived by applying the general

ideas of organization and specialization to this subject in the case of the individual manufacturer.

Whether employer and employee be organized in mutual bodies or not, one of the greatest needs of the present day is the development of some plan that will bring about a closer personal relation between them. To the loss of this "personal relation" and feeling of mutuality of interest can be attributed most of the trouble of the present day. In this day of huge corporations the employers are entirely out of touch with their workmen. That this works untold harm cannot be doubted. Most employers are fair-minded and would be willing to grant to their employees justice in regard to any complaints that they may have. The majority of them are willing that their workmen shall earn as large a wage as the conditions surrounding their business justify them in paying. The tendency amongst most of them is toward the providing of better working conditions for their employees. These facts are, however, seldom recognized by the workmen. Nor does it seem possible to cultivate any better feeling on the part of the employee toward his employer unless some attempt is made to restore the old-time "personal touch" between the two that to this day exists in the small shop. Trouble seldom comes upon the small shop, owing to the fact that difficulties are usually met and settled by the employer himself before they can grow into an unwarranted importance. Why not adopt a plan in the case of the large corporation that will ensure that all difficulties shall be met in the same manner?

"The time to stop trouble is before it begins."—Some plan of organization must be adopted to make this possible. Some method should exist whereby employer and men could get together and discuss their mutual difficulties before trouble begins. For when once trouble does arise, and it has become so acute as to require the attention of the employer, he may be certain that by that time the feelings and prejudices of all who have attempted to handle the proposition have been aroused to a high pitch. There is certain to be a large degree of bad feeling and doubt of good intention on the part of both parties to the controversy.

Many times the workmen's proposal is too absurd for the employer to entertain for a moment. The workmen, on the other hand, often embittered by delays and lack of consideration on the part of their immediate superiors, at times insist upon its acceptance. Or, on the other hand, the employer upon considering the case, will often see in the proposal a large element of justice which he would have admitted without hesitation if the proposition had come to him "first-handed."

He however often feels obliged to refuse such proposals for the sake of discipline and his desire to stand by his subordinates. Many bitter strikes have occurred under such conditions—strikes which could have been easily avoided had the questions been met *fairly, firmly,* and ***promptly.*** Whether or not the proposals are fair, in either case most desirable results can be accomplished by giving them prompt attention together with just and firm consideration at the time when they are first presented.

Consider the actual questions that give rise to strikes, lockouts and, following these, arbitration and conciliation committees. Consider the gist of the questions that these important bodies must investigate after the trouble has reached the point where, for the sake of the manufacturer, the workman, or the public, they must be called upon. Are not they the practical and fundamental questions of wages, hours, conditions under which men work, discharges, unreasonable demands, unjustifiable and unreasonable rules and practices, restrictions upon employment, limitation of output, etc.? Should we not begin at the lower end of the problem and provide some adequate means whereby the manufacturer and his men can come face to face and consider these questions and problems, fairly and squarely, before the matters get to such a serious issue as to render it necessary to call in outsiders to make a settlement? And settlements so made are rarely wholly acceptable to either party to the dispute, and when finally accepted, leave behind a bitter feeling of resentment.

Both logic and practical experience show the necessity for developing some plan of organization to meet such conditions.

No better introduction to the discussion of the work of the labor department in large industrial organizations can be given than a quotation from Mr. Hermann Justi's address on "Arbitration" delivered at Minneapolis some months ago:

> "Organization of the Employer Class.—All talk of arbitration or anything akin to it is well-nigh idle unless we take account of organization—not only as applied to employees, but organization as applied to employers. Whether we oppose it or favor it, organized labor has come to stay, and it must therefore be considered because we must deal with it. The employer class must organize to a point of excellence and efficiency where organized labor will respect it.
>
> "I am convinced that only by organization can common labor get the maximum wages for its hire. I am equally well convinced that only through organization of the employer class will capital obtain from organized labor the most and the best service in return for the wages paid.
>
> *"It is my belief that all great departments of industry must have their departments of labor, if serious friction is to be avoided and wisely ad-*

> *justed. When we pause to reflect, is it not remarkable that all the departments of great business enterprises have their especially appointed heads to direct and to manage them, with the exception of the department of labor?* This is allowed to get along as best it can, and yet what department of any great business enterprise is of equal importance? This seems the more inexplicable and indefensible in view of the fact that when we reduce the whole problem of business competition to the concrete form, there are only two propositions after all with which the business man has to deal—the price of labor, and the rate of interest."

And are not these absolute facts? What work requires more specialization, more continuous and tactful attention, than the handling of the labor question? And yet upon whom does this delicate and difficult problem actually fall? Is it handled by a department composed of men specially fitted for this question by their education, broad study of labor, and knowledge of labor conditions all over the country? Men selected for their fair-mindedness and practical experience in handling large bodies of men, and of such character as to gain the confidence of the workmen? Men of experience in making labor contracts, who know where the rights of labor end and the transgressions of the rights of capital begin even according to the union constitution?

No! this is seldom the case. The active, actual, everyday working policy of handling labor, the part that is vital to the working man and the manufacturer, is dictated *not by him but by his foreman.*

The superintendent is usually so loaded down with duties and responsibilities that it is almost impossible for him to give this subject the close attention it deserves. Again, he is often in the same condition as the higher officials. He is seldom in close touch with the workers. The foremen who are superintending the departments are exercising the direct and consequently the real potential influence over the men for good or bad. No matter what the manufacturer may desire to do for his men, no matter what his actual policy may be, their feeling toward the firm is governed more by their feeling toward the man who has them in daily control than by any other factors. If this man is weak, the workmen will impose upon him and the company. If harsh, unjust, or inclined to "play favorites," they will be discontented. The foreman will either augment or annul the effect of any good action or purpose of the employer.

These considerations but still further emphasize the necessity for special departments, whose work may be developed along lines similar to those given herewith, and whose functions may be such as actual experience proves necessary.

Work of a Labor Department.—This department should be in con-

trol of the labor question with full authority to settle all questions that the men and foremen cannot settle. There should always exist the right of appeal to this department on the part of either workmen or foremen. It sould be its constant aim to settle all questions before they reach an acute stage and assume an unwarranted importance. The questions should be considered directly with the employees affected, no outside influence being permitted to enter. The department should also investigate those practices on the part of the workmen which are unjust to the firm and endeavor to have them corrected. In actual experience great good has been accomplished by investigating and taking up with the workmen such matters as restriction of output, opposition to improved machinery, unjust wage demands, unreasonably high wage rates, unreasonable opposition to justifiable discharges, etc. Many important matters bearing directly upon economy of production, efficiency of workmen, and discipline of the shop have been amicably settled, that would probably have ultimately resulted in serious trouble had they been handled through the usual course in the customary manner.

Such is the nature of the work that a standing advisory committee should be formed, composed of men who are highest in authority in the company, before whom shall be brought all important matters of labor policy and any very serious affairs that cannot be satisfactorily settled. This advisory board should be called together by the labor department on emergencies, and also for monthly reports, these reports to indicate clearly the nature of the troubles settled and progress made.

This work should not be undertaken in a spirit of hostility to the workman. It should be carried out along the lines of justice to all concerned, coupled with firmness in demanding and insisting that that which is right should be granted, and that which is wrong should not be tolerated.

Thorough investigation, prompt action, just decisions, and a firm stand for that which is right should mark the work of such a department.

Wage Question.—The importance of a just and scientific wage system, both from the standpoint of satisfying the workmen and of producing work with the greatest economy, can hardly be over-estimated. The lack of attention to this matter causes much of the trouble between employees and employer. Where it is possible, the supervision of the wage system, together with the power to advise the adjustment of inequalities in wages, should be committed to the care of this department.

This department can with great profit watch for undue shrinkage in output or any tendency toward its limitation. A study of the reason for such conditions, and the changing of the conditions themselves, are often vital to the success of the business.

Increasing the Efficiency of the Factory Force.—The important questions of "employment" and "improving the personnel of the factory force" have a most important connection with efficient production. That the efficiency of the factory force can be largely increased by scientific methods is a fact not generally recognized. In this connection, systematic steps to separate the poor workmen from the efficient for their education and improvement, or, in case they prove totally inefficient, their discharge, are important factors in improving a factory's efficiency. In a properly systematized factory it is not difficult to obtain very accurate information concerning the character, ability, and earning capacity of the different workmen, even though they number thousands. Such data are also valuable in checking up the discharges of the workmen, as any discharge for an unjust cause can be noted at once. The data for all of this work are usually found necessary for the proper use of a wage system. A full consideration of this part of the subject would require an entire article, hence it is not possible to elaborate upon it at this time.

Improvements in Working Conditions.—This department should investigate and have installed such improvements in sanitary and working conditions as experience has shown to be practical. The importance of such work when carried out along practical lines is becoming more and more apparent. It is thoroughly justified on the grounds both of humanity and of economy of production.

Study of Legal Decisions.—An acquaintance with legal decisions bearing upon the rights of capital as well as of labor is often very important. The study of associations of labor and capital and a knowledge of the conditions of both throughout the world are necessary.

Foremen's Meetings.—The work of such a department will be largely ineffective unless it has the support and co-operation of the foremen or men who are in direct charge of departments. These men should be brought into sympathy with its aims and purposes. Generally the responsibility for this labor question is something that they will gladly relinquish, but the seeming interference with their preconceived ideas of the boundaries of their own authority, which its work must involve, will be at first resented. Nothing, however, need or should be done to interfere with the necessary authority of a foreman.

These men must be instructed and trained in the best methods of handling men; most effective ways of increasing their working efficiency, in a manner not detrimental to their health; of increasing their interest in their work, and, especially in union shops, the most effective methods of securing the best results for the company and the men under union conditions.

Certain it is that this department must be so conducted as to deserve and win the confidence of the workmen and foremen in its fairness and firmness. Its decisions must be along the lines of honesty and justice for both company and men, and unless the foremen will give their support to this policy much of the effect of its good work will be lost.

In order to gain the desired results, weekly meetings should be held of all the foremen and assistants for the purpose of discussing the problems and difficulties that they meet every day and of finding some solution.

Where union conditions exist unionism should be discussed, frankly and fairly, in all its phases. The difficulties experienced in regard to it and methods of overcoming their troubles; the best methods of handling men and getting good work from them; methods of encouraging workmen to take more interest in their work; *methods of encouraging all workmen to attend their union meetings and to take an active part in the proceedings; encouraging good workmen to act as officers and members of union committees.* In many cases in my experience when unions were recognized by a company, foremen were found making it so unpleasant for union shop committeemen that only the worst and most radical men would serve; the better men not only would not serve on committees but would not even attend meetings, not caring to be identified with the movement, especially in view of the foremen's attitude. As a direct consequence of this policy the union leaders were invariably of the type that would continually stir up strife and trouble, and would insist, even to the point of strikes, upon the granting of the most unreasonable demands. The conservative men, bound by their obligations and by the company's acceptance of unionism, would be compelled to follow the lead of these men whenever trouble arose. In such cases a policy of encouraging the men to attend their meetings and serving on their committees will result in great good. It should always be kept in mind that these committees are not only the representatives of the men before the company, but also practically the representatives of the company before the unions.

The aims of such a method of education should be:

First.—The instilling into the minds of the foremen the general

policy of the firm upon labor matters. A foreman should not be permitted to adopt his own policy and enforce his own rules in regard to such matters, but should be forced to follow the lines laid down by the company and compelled to work in harmony with its general policy and so aid in the development of one harmonious plan.

Second.—The foremen should, through their discussions, get better ideas as regards the proper methods of handling men.

Third.—They should, if wisely guided, learn many things that would result in direct economies in their departments.

Fourth.—Such meetings should develop a most desirable *esprit de corps* amongst the foremen themselves.

Personnel of Labor Department.—It is evident that the men responsible for such work must be chosen with great care. Though representing the employers' interests, they must be careful to carry out the work in such a manner as to deserve and gain the confidence of at least the more conservative elements in the body of workmen. In this plan the introduction of any of the employees as members of the department is not contemplated or even suggested.

More will depend upon the ability, character and experience of the man at the head of such work, than upon any other factors.

He should have had a wide experience in the handling of large bodies of men, both union and non-union. He should have an acquaintance with the heads of existing manufacturer's associations and prominent labor leaders, as well as a thorough knowledge of union methods. He should be thoroughly informed on modern factory systems and methods, especially as applied to wage systems. Mechanical experience is very desirable. Inasmuch as many of the disputes that will arise will concern the question of wages and output, he should be able to devise methods of ascertaining the output that could be fairly expected from any job. He should be capable of introducing methods of increasing the interest of the workmen in their tasks. Such work requires a combination of tact, good judgment, experience in handling men, and executive ability and fairness. In short the man guiding such a department, formed to undertake such work as a safeguard to the company's interest, should possess no small degree of ability. No work is more worthy of the close attention of those high in authority in the company. It is indissolubly linked with the highest and most important interests of the employer. The commercial success of any business depends upon the securing and developing of markets, the development of the economic possibilities of the factory, and the existence and continuance of satisfactory relations between employer and employee.

As can be seen, the work of a labor department, properly developed and carried out, is vitally concerned with the last two factors mentioned.

Such methods have been carried out by the labor department in a large corporation for over a year. It was originally organized by Mr. John H. Patterson, president of the National Cash Register Company, and has been developed along the lines laid down in this article.

This particular company employs almost four thousand men. It is thoroughly unionized, there being represented in the factory eleven international union organizations, twenty-four local unions, and thirty-six shop committees. The policy outlined has had its vindication through the change in the attitude of the workmen. The men now limit their complaints to those which are fair. They deal directly with the company through its labor department, many questions being settled before they are brought up in union meetings.

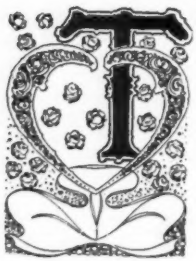
Representative workmen are chosen for the officers and committees. Very little outside influence is brought to bear upon matters that pertain to the shop. Most of their former illiberal practices are done away with. The tendency is constantly toward a more conservative policy. The practical results attained in this case have more than justified the assertion made of the needs and value of such systematic work directed by a well organized department.

Whether or not a factory is unionized, it is certainly advisable to make a careful and unbiased investigation of actual conditions and ascertain what causes for dissatisfaction exist between the workmen and the management. See that opportunity is given the men to earn a wage such as the business can afford to pay under such a system of pay as is both economical and just. Provide them with sanitary conditions which modern industrial science has demonstrated it pays the employer to give them, and which humanitarian principles dictate as just and fair. Try to establish relations of confidence between yourselves and your employees and provide some means whereby you and they can meet on common ground, so that each can learn of those things that are unfair in the attitude or conduct of the other, and consider these in the spirit of justice. Hear their complaints, correct promptly all evils, insist that they do their share, and that they too correct the evils that they are responsible for, and the desired result will in time be attained. This does not by any means imply a weak policy of handling the question. It is the policy of strength.

PRACTICAL ECONOMY IN THE POWER PLANT.

By W. H. Booth.

Mr. Booth's chief proposition is an enforcement of that stated elsewhere in this issue by Mr. Kimball—that the successful engineer must take full account of the commercial factors in the problems he is called upon to solve. The maximum of efficiency is not of necessity to be found in the closest approach to a certain formula or thermodynamic equation, but in the largest useful return for the input of money and work. It is only when "theory" ignores some of the necessary conditions that it can ever appear to be at variance with "practice." And deductions thus postulated on incomplete or inexact premises are not "theoretical" but "hypothetical." When "all the conditions there are" are recognised, the theoretical and the practical are seen to be, as they needs must always be, identical.—THE EDITORS.



HE end and aim of the engineer is primarily to reach his purpose without unnecessary expense. It is therefore requisite for him to be possessed in the first place of a sufficiency of technical knowledge to enable him to grasp the scientific and technical points on which economy must be based. It is comparatively an easy matter to secure economy of this order; but in doing so the engineer will come into more or less unpleasant contact with other objects of more or less fixity of purpose, and will find that even in seeking a primary economy there are so many difficulties in the way that the economy often melts away.

Let the apparently simple question of fuel combustion be taken as an illustration. An engineer coming fresh upon the field of steam engineering would find steam production carried out on lines that he would perhaps conclude were sound and good. In seeking economy along these lines, he would speedily find that certain furnaces could not do their duty without smoke production. Others, again, could work smokelessly, but at less economy than if allowed to produce smoke. In seeking after perfection, he would find himself confronted with the necessity of using Welsh coal at heavy cost in some furnaces, and an excessive amount of air in others. If, being of a more commercial turn of mind, he tried to use the cheaper coal, he would finally succumb to the difficulties of the position, throw æstheticism to the dogs, and pour out huge volumes of smoke. He would then have solved the problem of commercial economy so far as his apparatus allowed him. He might rest contented at this, did not his filth produc-

tion bring him into contact with the Smoke Prevention Act. Unless he was in charge of a steam plant so large that the economy of the smoke-producing coal was greater than the expense of fines, he would find that finality had still not been attained, and he might spend weary years on the usual practice of trying quack remedies and nostrums so as to prevent the formation of smoke in improperly constructed furnaces.

Did he, however, possess a sufficiently sound knowledge of the principles of combustion, he might study the question more deeply and find that the existing furnaces owed their forms entirely to a desire to secure a primary economy. The furnace arrangements of almost every boiler sold are based on a minimum first cost. This is the outcome of competition. No maker of boilers dares to advocate the placing of his boiler in a setting of greater cost than asked for by his rival, and engineers apparently have not perceived that the cheaper mode of setting is alone responsible for all the expense in dearer fuel, smoke fines, nostrums, and experiments to which they have been subjected.

In questions of steam using as distinguished from steam production, engineers have certainly not erred in the direction of reduced first cost. Large amounts of capital have been expended on steam engines, on the buildings to contain them, and on tiles, mosaic work, and carpets over which to approach them, by men who would refuse to spend a shilling upon the more important department of steam production. The steam engine lends itself to impressive treatment. It looks well and gathers about it a very considerable amount of sentiment. Engine attendants have been known to weep over the scrapping from old engines. No man has been recorded to have wept over a steam boiler from any feeling of affection for the boiler.

The sentiment attached to the steam engine resulted in a rivalry which has done something to make the engine better, but an entirely false economy has arisen measuring the performances of an engine along lines which do not find a place in the life history of that particular engine. The old-fashioned idea of engine economy was based on the amount of coal consumed per indicated horse power. The indicated horse power was the unit employed because it was a unit that could be ascertained by means of the indicator with a reasonable approach to accuracy. The coal was the unit of consumption employed because it was easily measured and it brought into the sentimental rivalry the steam producer—and, so far, this was commercially sound, because it compelled the attention of the men in charge to the whole range of

plant and not to one corner of it. It was partially because of this that the steam engineering of the cotton factory was always better than that of the electrical station.

The employment of coal as a basis of comparison is not held to be correct today, because it confuses the engine performance with boiler performance and prevents accurate information being secured from either. But it suited the mill owner who paid for so much coal and spun so many thousand pounds of yarn, and compared his results with those of his neighbour whose factory was so very similar to his own that the results were fairly indicative of the excellence of the engineer in charge.

The use of the indicated horse power as a unit was of course liable to give rise to error. It did, in fact, do so. It would have been better to have instituted further comparisons and taken into account the number of spindles turned per pound of coal and the indicated horse power. Discrepancies would have become apparent, and factories using 3 pounds of coal per indicated horse power might have been found to turn more spindles per horse power than other factories where the coal per horse power was 2¾ pounds per hour. The brake horse power was never known in those factories. Engineers rarely ran a friction load, to do which involved disengaging a toothed wheel or removing the driving ropes—a heavy and lengthy operation. In the absence of this information as to the brake horse power, the indicated horse power became the fixed unit of comparison and the result was to favour the excessively large engine and encourage the use of mean forward pressures much too low. It is also probable that the compound engine was encouraged unnecessarily. The compound engine no doubt frequently had a larger frictional load than the simple engine, and gained where coal was stated in pounds per indicated horse power in place of per brake horse power. In this way uneconomical errors crept into practice. In more modern installations of steam plant many errors have also crept in.

Striving after ultra-scientific accuracy, the steam-producing department has been put aside and separated from the steam-using and more fashionable department to which professors and *dilettanti* have given their attention to the exclusion of the unfashionable boiler. Much wisdom and disputation has been expended upon tests for dry steam, though it is well-known that there is no means of collection of true samples of steam and that the only proper steam to use is that which, when tested by a thermometer, is found to be something above its saturation temperature. The unreliability of many engine tests is

amply illustrated by the records of 96 and 97 per cent. which some engineers have not hesitated to publish and to stick to. A sort of false doctrine of engine performance has sprung up, and engines are run for unnecessary hours at steady loads to determine their suitability for their daily load, which in cases of a traction or power-distribution load is never steady for many seconds at once and only at rare intervals approaches that load at which the engine is understood to be most economical, and at which its guaranteed performance has been paid for—perhaps to the extent of a bonus. Here again a lack of the sense of proportion in the engineer has caused the expenditure of unnecessary capital. At its steady full load, the compound engine at its proper pressure will be more economical than the simple engine under similar favourable conditions. The economy of the compound engine is made up of several items. It has a smaller range of temperature in any one cylinder. It has less periphery of leakage in its pistons and valves exposed to boiler pressure; and it has less severe stresses. Taken together, it is more economical; but it is given high-pressure steam to work with, and much of the economy of the compound engine in reputation is what it earned when higher steam pressure was inaugurated simultaneously with the compound principle. One might ask in regard to the combined effect of compounding and higher pressure:

"Who was the potter then and who the pot?"

But while it may fairly be conceded that the compound engine is the better engine where compound-engine conditions of load and pressure are present, it may well be doubted if there has not been some misconception, some false notion of economics, at the root of the matter—our inability to grasp the true proportions of the subject. The cost of running any steam plant is made up of the capital charges on the cost, the cost of fuel and wages, and maintenance. Capital charges include those of buildings. Any falling off in engine economy may increase the capital charge on the boiler account, and this must not be forgotten. But the crux of the matter is the load. Every engine must be capable of turning the maximum load which may come upon it. In all compound engines the maximum load that can be turned is that represented by an admission of steam practically full-stroke of the first cylinder. The economical load is probably represented by a steam admission of a third or a fourth of the first cylinder. Thus at its maximum load the engine can use only three or four times so much steam as at its economical load, whence follows that for very variable loads, as in the case of all small tramway systems, the compound engine will be too large for its average load if it is able to turn its maximum load. Without

going into the figures it is obvious that a simple engine of very much less size can be put down at less expense, which, while capable of turning its very occasional maximum load by means of full steam admission, will yet work ordinarily at its economic load. Being small, its piston and valve periphery for leakage will be little more than that of the larger compound engine. The use of superheated steam will eliminate much of those cylinder losses that have given the compound engine an advantage hitherto, and in addition there are the many considerations of weight and space which all tell in favour of the simple engine.

The object aimed at by the tramway engineer is not primarily to be even coal economy per kilowatt, for station economy will always be at its best where the coal economy is some distance short of best. Neither is it necessarily best economy to run the tramway at the smallest output in kilowatts per car mile. The minimum output is not consistent with the minimum of total costs. Capital charges on distribution mains are considerable, and in order to save mains it will pay to burn more coal and waste current in overcoming the resistance of smaller mains.

Engineers have too frequently confined their energies to the merely technical side of their profession, yet when technical knowledge has been required they have failed to possess it. They have, in fact, paid more attention to the more attractive departments. Hence the giving over of the steam-raising department to the business man, who has failed to perceive that the proper combustion of expensive fuel lies at the basis of economy. Hence also the expenditure of untold energy in perfecting steam engines to an academic pitch of perfection, to testing them on mere academic lines and under non-practical conditions as to load. Engineers have, in fact, allowed personal inclination and sentiment to override judgment, and the result has been that public sentiment and æsthetic instinct, poorly developed as they may be, have been outraged by the filth of incomplete combustion, for which the unjustifiable excuse is tendered that it is unavoidable. The same lack of the sense of proportion is also specially characteristic of the architect, who whether he is providing steam-plant accommodation or looking after sanitary necessities, appears to exercise a particular malevolence toward these branches of a profession he does not understand, until an architect's engineering or sanitary work has become a bye word and a reproach. A familiar example of uncommercial engineering is afforded where on a line of electrical tramway of very few miles in length a high-tension system of transmission with sub-station transformation is employed. There is a point where high-tension systems

must obviously be employed, but good judgment must be exercised before adopting it.

Every up and down transformation of energy involves a loss of probably not less than 3 nor more than 5 per cent. In high-tension transmission there is a loss in the step-up transformation from the pressure of generation to the line pressure; a loss in stepping down; a loss in transformation to direct current. The three losses may leave only 85 per cent. of the generated current to go out on the line.

Expensive machinery is involved and complicated switch-boards and substation buildings. Cables must be provided in any case, and the cost of these will be a large proportion of the cost of low-tension cables. The cost of laying may be but little less. The cost of insulation will be at least greater per pound of copper. If all the additional expense of transformation were put into extra copper in the distribution cables for a low-tension system, it is probable that the commercial limit of the low-tension system would be moved considerably upwards. Moreover, copper in mains has a scrap value much above that of an equal first cost of sub-station, switch gear, and machinery. A loss of 10 to 15 per cent. of current, which is inevitable in the high-tension transformation, allows of considerable loss in a direct-current system.

There can be no question as to the economy to be derived from working on the condensing principle. Especially is this the case where, as in traction work, the mean pressure is low. By condensation it is claimed that as much as 40 per cent. economy may sometimes be secured. Many power stations are placed away from a free source of water, and great expenditure has been incurred in providing special means of cooling the water, such as towers and fans. This involves a considerable waste of power and it is doubtful in many cases if the expenditure of power on fans is worth the difference between a fan tower and a natural-draught tower. Here also comes in the question of high-tension transmission. If it is ever worth while to incur the complication of a high-tension system, it should be made to afford the engineer some latitude in the choice of a site easy of access for coal and water, so that the full benefit of condensing may be made to represent an advantage on the side of the high-tension current.

In almost no case can an engineering economy ever be pushed to its full face value. There is always some point short of maximum primary economy at which it is desirable to draw the line. Almost all curves of performance on economy approximate to the hyperbolic order. There is a rapid start, and then beyond a certain point the curve becomes more and more flattened and parallel with a straight line.

Even in an adiabatic cylinder of a perfect steam engine the gain due to further expansion of the steam is so small beyond a certain point that the size and cost of a steam engine would become excessive, and interest costs would eat up fuel saving. In practice, the extra friction of a large engine puts an early limit on expansion, and the action of the cylinder metal still further limits the possible economy of expansion

Similarly in ocean steamships the commercial limit of speed is reached sooner than recent examples would lead one to believe.

The absolutely callous indifference of the Atlantic greyhound to all small craft may someday produce such disaster as will upset the public sentiment for saving an hour on a week's voyage, which alone has so far enabled the fastest ships to pick up the cream of the traffic, and to sacrifice everything to speed by filling up their whole space with power plant.

No matter which way we may turn, we are confronted with the fact that efficiencies, economics, and costs do not run in straight-line curves, and that it is unsafe to assume a long-continued curve from a few points in its early development. This assumption has been a cause of immeasurable miscalculation and commercial failure. Processes and improvements that, like the lower grades of steam expansion, show huge economies, do not continue to show a uniform rate of economy and a limit is soon reached to progress in any one direction. It is the same in mining. The last grain of gold per ton cannot be got at a cost which pays for a white man's process and a white man's living rates. Some fraction must always remain, out of which the Chinaman can fossick out a living on a less luxurious plane.

Such instances might be multiplied an hundredfold. They show a lack of the sense of proportion, without which engineering cannot be carried out on the lines of that true economy which is included in the term "Commercial Engineering."

MODERN MACHINERY FOR EXCAVATING AND DREDGING.

II.—DREDGES FOR TIDAL HARBOURS AND DEEP WATERWAYS.

By A. W. Robinson.

In a preceding article Mr. Robinson pointed out the great and increasing influence which economy of transportation has upon commercial prosperity, and discussed the steam shovel and the dredge as the principal means for increasing that economy by preparing the way for the efficient carriers of cheap freights—the locomotive and the large steamship. The first half of his review dealt more particularly with machines for cutting the roadways of internal communication. This takes up the heavier types more closely adapted to harbour work or deep waterways, such as the Isthmian Canal.—THE EDITORS.

HAVING described in the former article the steam shovel for land excavation, and the first two types of dredging machines for sub-aqueous dredging—namely, the ladder dredge and the dipper dredge—it now remains to describe the hydraulic and the clamshell types of dredge.

The hydraulic dredge is a later development and bids fair to outstrip in importance the other three. It is yet in its earlier stages, and its possibilities are but imperfectly understood. It is more sensitive than other types to suitability of conditions, and is therefore a special and not a general-purpose machine. The dipper type of dredge may be what is termed an "all-around" dredge, and may work in a variety of material and under different conditions. The hydraulic dredge on the other hand, in its earlier forms at least, is restricted to soft or homogeneous material, although later forms of mechanical cutters have greatly widened its usefulness. Its strong points are continuous operation, large capacity, and facility of transporting and disposing of the material as well as dredging it.

Hydraulic dredging has been known and practiced for about forty years, although it has been slow of development, and of late years it has been retarded by litigation in the courts over patent rights.

The first important consideration in a hydraulic dredge is the character of the material, and the second the method of its disposition. Perfectly free material, such as sand or soft mud, can be pumped by the suction alone; but more compact ground such as clay, stiff mud, or earth requires to be mechanically excavated. The main function of the

hydraulic action is the transportation of the dredged material, and it has been largely because of this feature that this type of dredge is able to show such satisfactory results.

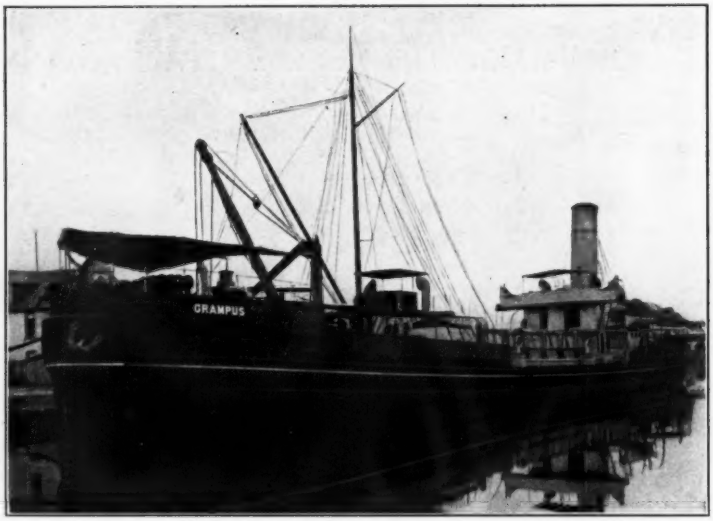


FIG. 20. SEA-GOING HOPPER DREDGE GRAMPUS, GOVERNMENT OF NATAL.

Twin-screw suction pump. Hopper capacity 1,200 tons; pumping capacity 3,000 tons per hour. Wm. Simons & Co., Ltd., Renfrew.

Theoretically, the transportation along with the dredged material of four or five times its weight of water, and the pumping of it against high heads at high velocities with great loss by friction in the pipe, is a very wasteful proceeding; but all dredging methods are wasteful, and the percentage of useful work done in proportion to power expended is very small. The most practical measure of efficiency, therefore, as a basis of comparison with other types, is the cost per cubic yard of material dredged and deposited at a given distance and under given conditions. Measured by this test and under suitable conditions, the hydraulic dredge can be made to show good results, and the cheapest dredging yet recorded has been done by this type.

There are advocates of the hydraulic dredge who make extravagant claims for it and who know no other type. It is well to recognise the limitations of each type, and in carrying out a given piece of work so to

The numbering of the figures is consecutive with that in Mr. Robinson's article in THE ENGINEERING MAGAZINE for March, 1903.

adapt the means to the end that the best results will be secured. Each type has its own value in its own field of work; the other types can do work that the hydraulic type cannot do at all, and *vice versa.*

Briefly, the hydraulic dredge may be divided into four leading types:

1.—The sea-going hopper type.

2.—The lateral-feeding or ship-channel type with floating discharge pipe.

3.—The forward feeding or Mississippi type, with floating discharge pipe.

4.—The radial feeding, with spud anchorage and floating discharge pipe.

An example of the first or sea-going hopper type is illustrated in Figure 20 by the dredge Grampus. This vessel is one of several built by Wm. Simons & Co., of Renfrew, Scotland, for the government of Natal. The Grampus is 218 feet in length, 30 feet 6 inches beam, and 16 feet 7 inches deep, and has a hopper capacity of 1,300 tons. It has a suction pipe 44 inches in diameter which is fitted in a central well in the fore part of the dredge and is flexibly connected in such a way that the dredge can plunge about to a great extent in sea waves without interfering with the operation of dredging. These dredges are naturally subject to delays from storms, etc., and having to transport the material to sea the actual dredging time is comparatively small. For this reason the pumps are given very large capacity so that the hoppers can be filled in about thirty minutes. A similar dredge called the Walrus in 1899 dredged and deposited at sea 1,103,000 tons of sand at a cost per ton of 1.984 pence. This is equal to about 760,000 cubic yards at 5.75 cents. Dredges of this type are necessary for deepening the bars that form at the mouth of nearly all rivers which carry alluvial matter, or have a sandy estuary.

In Figure 21 is shown a smaller dredge of this type called the Forshaw. This dredge was built in 1897 by Lobnitz & Co., of Renfrew, Scotland, for the River Ribble Navigation Commissioners of England. This dredge is 117 feet long, 36 feet beam, and 14 feet deep. It has a hopper capacity of 20,000 cubic feet. It has one triple-expansion engine of 650 horse power which drives the propeller and also drives the centrifugal dredging pump, which is connected to the forward end of the engine by a clutch. The suction pipe goes through the side slightly below the water line and leads forward, terminating in a plain end with grating. The method of dredging is to drop the bow anchor and feed slowly forward, the suction pipe making a conical hole or trough in the

FIG. 21. SEA-GOING HOPPER DREDGE FORSHAW, WEST COAST OF ENGLAND.

bottom as the sand flows to the suction pipe. The dredge carries a crew of eight men and a boy, and dredges and deposits the material a distance of 12 miles for a cost of about one penny per ton. The cost of the vessel complete was £20,000. This dredge represents the hopper type in a very simple form and cheaply operated, and for the particular work it has to do it is very satisfactory. It was followed in 1899 by a duplicate dredge. Owing to the high tides on this river, navigation is entirely suspended at low water, as the river empties out nearly dry. The dredge is thus able to make only one trip on each tide, and under these circumstances the performance is very creditable.

In Figure 22 is shown the large sea-going hopper dredge Thomas. This dredge is one of two which were built in 1900 by the Maryland Steel Co., at Sparrows Point, Maryland, for the Metropolitan Dredging

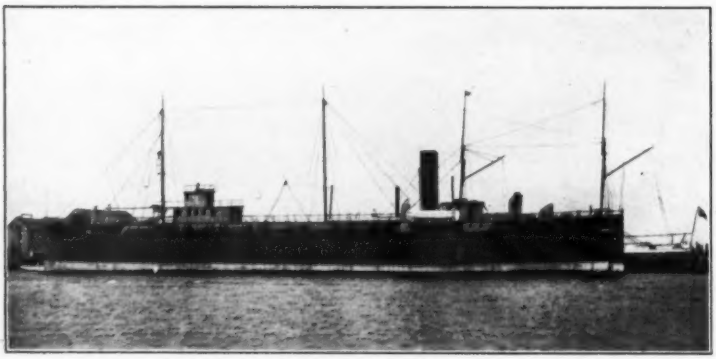


FIG. 22. SEA-GOING HOPPER DREDGE THOMAS, NEW YORK HARBOUR.

Company of New York for the deepening of the outer channel of New York harbour. These vessels are stated to be the largest dredges in the world. They are modelled after the dredges Brancker and Crow, which have done such successful work for the port of Liverpool at the mouth of the Mersey. They are, however, more capacious than the English dredges, being 300 feet long, 52 feet 6 inches beam, and 25 feet deep, and the hoppers have a capacity of 2,800 cubic yards. The Liverpool dredge Crow is illustrated in Figures 24 and 25. The contract on which the Thomas is engaged is to remove 40,000,000 cubic yards of sand at 9 cents per cubic yard. These vessels have been described and illustrated in various periodicals, so that a detailed description of them is not necessary here.

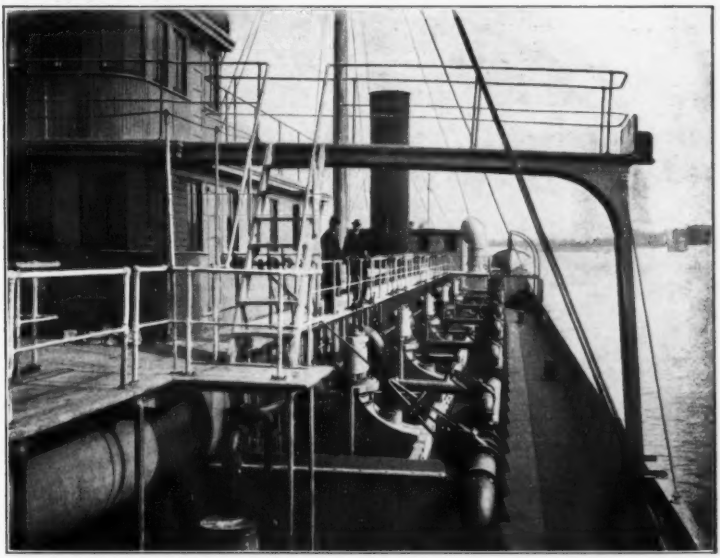


FIG. 23. VIEW ALONG THE DECK OF THE SEA-GOING HOPPER DREDGE THOMAS.

A number of sea-going hopper dredges, of comparatively small size have been built for the United States government for the various ports along the Atlantic Coast. Among these may be mentioned those at Cape Fear River, Winyah Bay, S. C.; Charleston, S. C.; Pensacola, Florida; Sabine Pass, Texas, and Galveston, Texas. These dredges were built by contract from designs prepared by the U. S. Corps of Engineers. For the most part they have wooden hulls, wood being preferred to steel as being more elastic in case of pounding on the

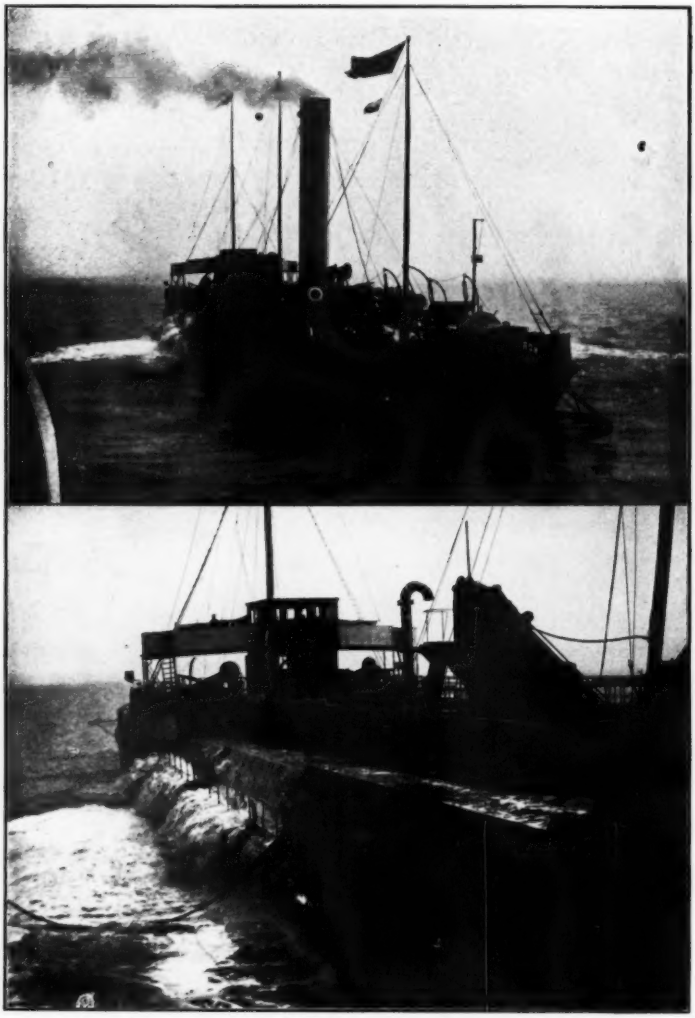


FIG. 24-25. SEA-GOING HOPPER DREDGE G. B. CROW, PORT OF LIVERPOOL, AND VIEW ALONG HER DECK.

shallow bars, and it is considered by some to be more durable than steel in the semi-tropical waters of the South Atlantic. The increasing scarcity of wood will, however, eventually cause it to be abandoned for hull building.

The power required for pumping is much less in the hopper type of dredge than in the other three types using a long discharge pipe to transport and deposit the material. For long-distance pumping the power required is very great in order to overcome the friction in the pipe at the high velocity. A pump that will do fair work in hopper loading would be useless for long-distance work. Such pumps must be specially designed, and in many cases must be capable of overcoming a total head of 80 to 100 feet.

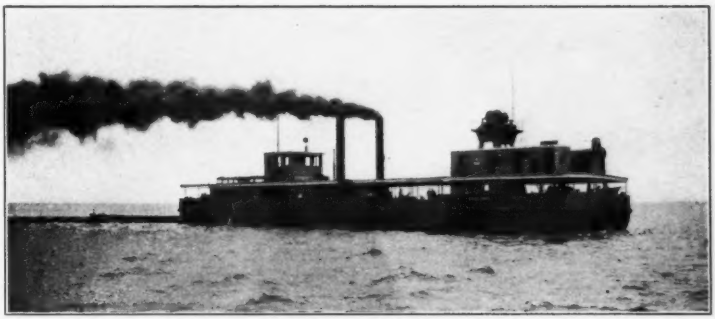


FIG. 26. HYDRAULIC DREDGE J. ISRAEL TARTE, ST. LAWRENCE RIVER.

The second type of dredge is that having a lateral feed and is exemplified by the dredge J. Israel Tarte in Figure 26. This is, in fact, the only hydraulic dredge of which I know that has a lateral feed of 450 feet, so that it can make a ship channel of that width in one cut. This dredge was built in 1901 from my designs by the Polson Iron Works of Toronto, Ontario, for the Canadian government, and is employed in deepening the ship channel of the River St. Lawrence below Montreal. The hull is of steel, 160 feet long, 42 feet beam, and 12 feet 6 inches deep, and the main pump has a suction pipe 40 inches in diameter, with 36-inch discharge pipe 2,000 feet long. The dredge is operated entirely by wire-rope anchorages, and the suction pipe passes through a well in the centre of the vessel. The material in which this dredge works is blue clay and it is excavated by a mechanical cutter. This cutter is 9 feet 6 inches in diameter and weighs 10 tons, and with its engines and mountings is of the most substantial description so as to avoid possibility of breakdown or delay. The mooring ropes are

FIG. 27. PIPE LINE OF HYDRAULIC DREDGE J. ISRAEL TARTE.

arranged in such a way that the operation is practically continuous. During the month of September, 1902, the output of this dredge was 580,000 cubic yards, and in October 600,000 cubic yards, or 1,180,000 cubic yards for two months. This was in 26 working days per month of 24 hours. As far as I am aware, this marks a world's record for output, measured by the month, of any dredge under any conditions.

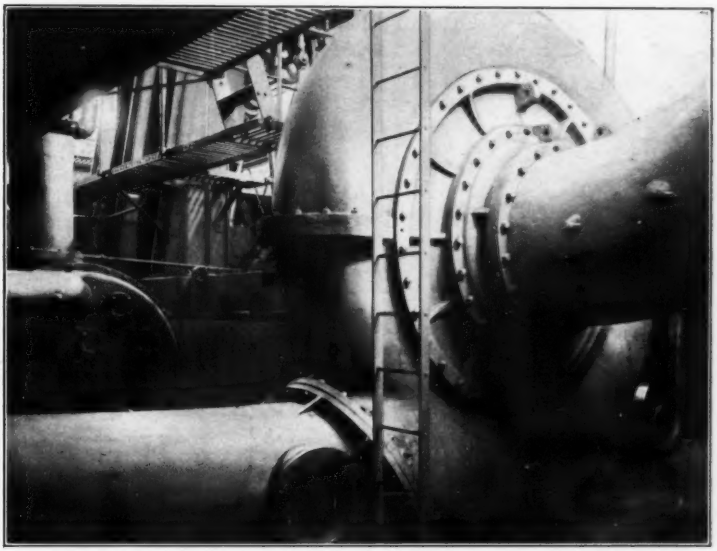


FIG. 28. MAIN PUMP OF THE HYDRAULIC DREDGE J. ISRAEL TARTE.

The quantity of work done was ascertained by taking the position of the dredge on the first of the month and again on the first of the following month, and measuring the distance of length of ship channel completed in that time. As the cross-section of the cut was practically uniform and the material blue clay, which remains permanently in place, the work of the dredge could thus be arrived at with a fair degree of accuracy. The quantity stated is increased to scow measurement to compare with the other dredges on the same work which load into scows, on the basis of place measurement being 80 per cent. of scow measurement. Larger outputs per hour have been claimed for sand-pump dredges on the Mississippi and elsewhere, but these tests were made for a few minutes only by barge tests, and in loose sand and at comparatively shallow depths. I believe that the only proper way to

measure the work of such a dredge is as described for the Tarte, and charge to the dredge all delays of whatever kind.

The main engines of the Tarte are of the triple-expansion type of 1,000 indicated horse power.

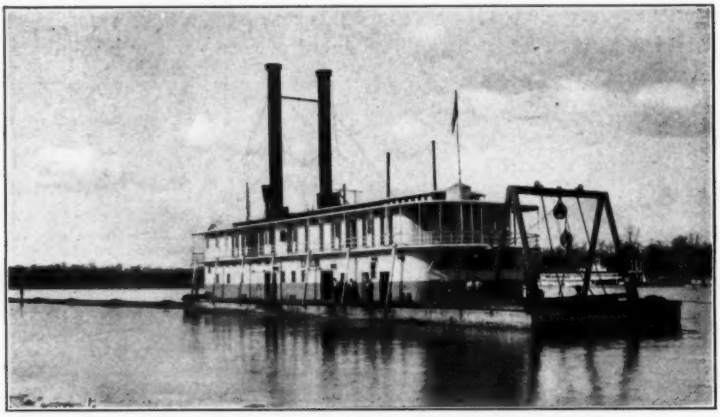


FIG. 29. HYDRAULIC DREDGE EPSILON, MISSISSIPPI RIVER.

It thus appears that America possesses the largest and most costly dredge in the world, as exemplified in the Thomas and Mills in New York harbour, and the dredge holding the world's record for the largest output for two consecutive months in the J. Israel Tarte, of Canada. It will probably not be long before these records are exceeded, as the modern tendency is towards large power and capacity.

We come now to the third type of hydraulic dredge, or forward feed, as exemplified by the great dredges of the Mississippi River. This type is illustrated by the dredge Epsilon, in Figure 29. The Epsilon is the fifth dredge of a series of ten dredges which have been built for the Mississippi and Missouri Rivers. It was built in 1898 at a cost of $102,000 and has a steel hull 157 feet long, 40 feet beam, 7 feet 9 inches deep, and draws 4 feet of water. The main pump has 32-inch discharge pipe 1,000 feet long, and the main engines are of 650 indicated horse power. Steam is furnished by boilers of the externally fired Mississippi River type, 48 inches in diameter by 28 feet long, the working pressure being 150 pounds. Some of the later dredges have been made self-propelling with side-wheels, and improved in detail, but the general type is the same. The details and results of these dredges have been already fully published.*

* Trans. Am. Soc. C. E., June, 1898.

These dredges are stationed along the river at various points during the low-water season for the purpose of opening a passage through the sand bars which obstruct navigation. The bottom of the river is continually changing and these sand bars do not make trouble until the low-water season; it is then necessary to do a large amount of work in a very short time in order to afford relief and permit the passage of the river steamers. The dredge therefore makes a straightforward cut across the sand bar, making a passage about the width of itself at a rate of advance of from 10 to 30 feet per minute. The floating discharge pipe deposits the sand in the deep pool below the bar, and the dredge is hauled ahead by means of steel-wire ropes attached to anchor piles which are sunk in the sand by the hydraulic method. These dredges work to a depth of 12 to 20 feet and have proved very satisfactory in service for the purpose intended. The alluvial formation through which the river flows is such that the work done has no permanence, and it therefore represents a continual expense each year; and on account of the short season and intermittent work, the total number of cubic yards dredged is comparatively small.

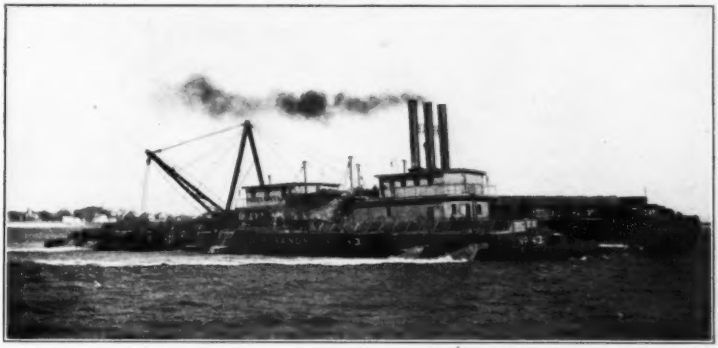


FIG. 30. HYDRAULIC DREDGE NO. 2, NEW YORK HARBOUR, LOADING TWO 1,800 YARD BARGES SIMULTANEOUSLY.

The initiation of this method of dredging on the Mississippi River is largely due to the efforts of the late Henry Flad, M. Am. Soc. C. E., who began his experiments which culminated in the dredge Alpha at a time when no such dredges were in existence, and when his ideas as to dredging sand on such a scale were thought to be chimerical. The Alpha was built in 1893 and had a wooden hull 140 feet by 36 feet by 8 feet, with a centrifugal dredging pump having 30-inch discharge and of 300 indicated horse power. The success of this dredge was undoubted, but it was felt to be largely in the experimental stage and

the Misissippi River Commission called publicly for plans to be submitted for the best dredge of this type. After considering some twenty proposals they reduced the number to three, and awarded a contract to each of the three bidders to construct their own designs with a view to ascertaining by experiment the results of each. This resulted in the construction of the Beta from designs by Lindon W. Bates, of the Gamma from the writer's designs, and of the Delta from designs by the New York Dredging Co. The comparative cost and efficiency of the three dredges is exhibited in the following table:*

Dredge.	First cost.	Operating expenses per day.	Test Output. Average cubic yds per hour.	Test Output. Cu. yds. per horse-power per hour.
Beta	$218,162	$221.63	4,920	2.00
Delta	124,940	111.76	1,829	1.62
Gamma	85,530	100.51	1,523	3.28

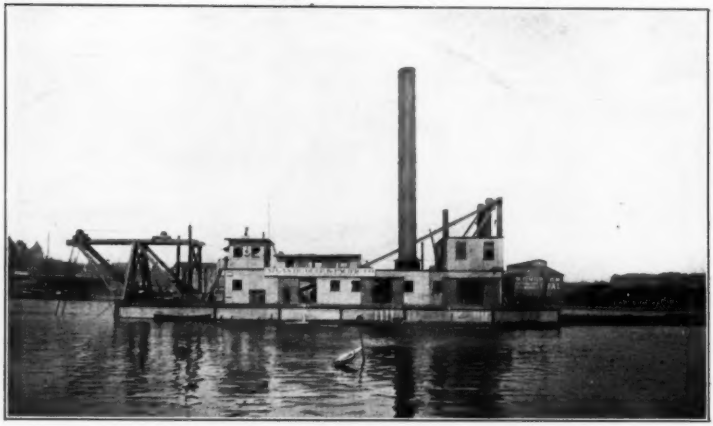


FIG. 31. HYDRAULIC DREDGE NO. 3, ALBANY, N. Y.

The fourth type of hydraulic dredge, or that of radial feeding with a stern spud anchorage, is exemplified by the dredge King Edward and illustrated in Figure 32. This type of dredge is specially adapted for pumping material ashore and making land, etc. This kind of work is illustrated in Figure 33, which shows the dredge in the distance and the manner in which the material spreads itself by hydraulic action. This dredge was built from my designs for the Canadian government, for the Pacific Coast port of British Columbia. Being intended to do a variety of work at points distant from one another, it is made self-pro-

* See "Correspondence on Dredges and Dredging," Trans. Am. Soc. C. E., Vol. XL., p. 347.

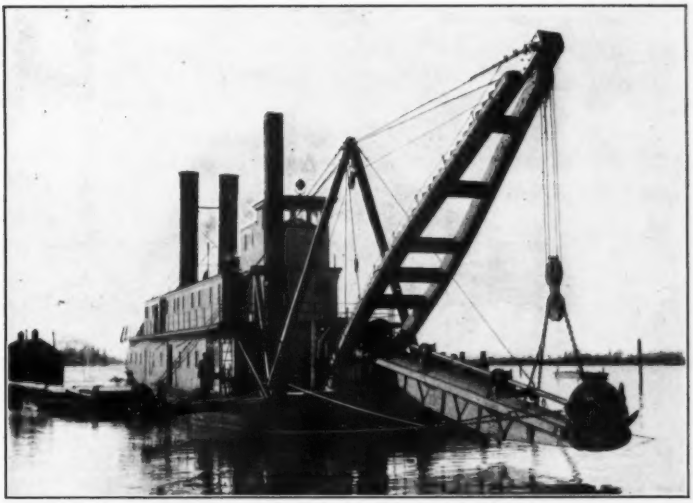


FIG. 32. HYDRAULIC DREDGE KING EDWARD, BRITISH COLUMBIA.

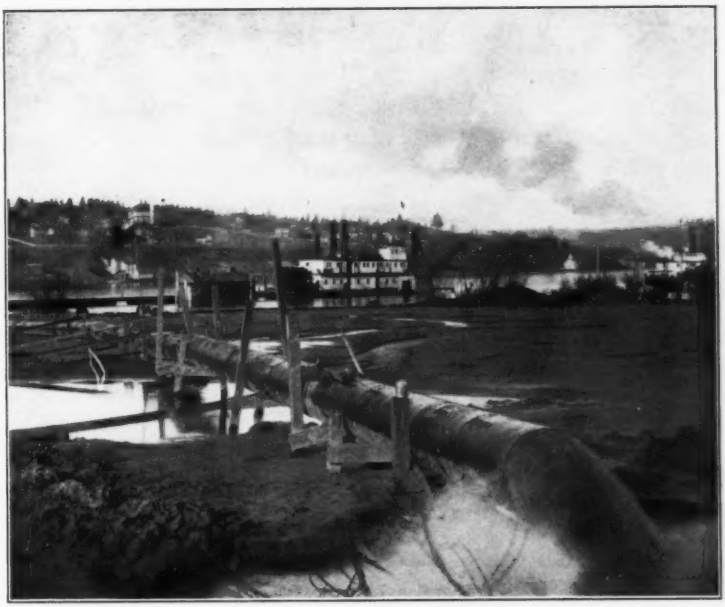


FIG. 33. SHORE DISCHARGE OF HYDRAULIC DREDGE KING EDWARD.

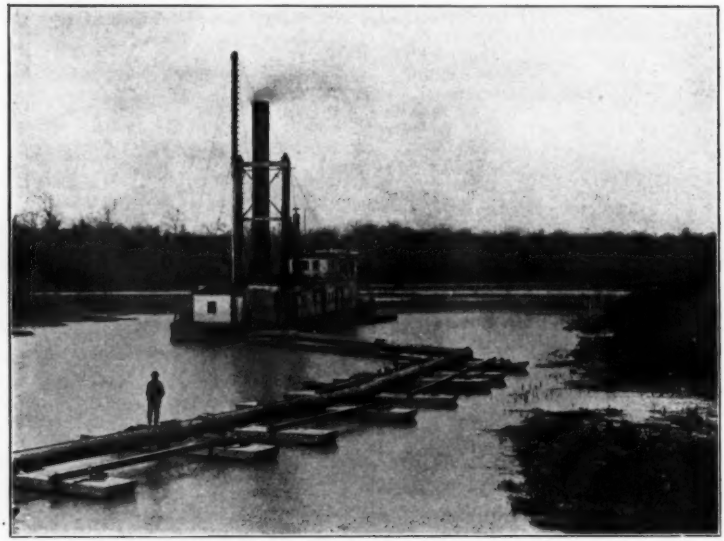


FIG. 34. 20-INCH HYDRAULIC DREDGE, VICKSBURG, MISS., MAKING NEW CUT TO RESTORE RIVER NAVIGATION TO THE CITY.

pelling by means of a stern wheel of the river-steamer type so much used in the West. The hull is of composite construction and is 125 feet long, 32 feet wide, and 7 feet 6 inches deep. The suction pipe projects over the bow and is of the universal swing type, that is to say it can swing upon the hull while the latter remains stationary, thus making it useful in getting into corners and confined places. It can also make a cut 125 feet wide by swinging the entire dredge on a stern spud. The dredge is fitted with a mechanical cutter with renewable steel blades. The suction and discharge pipes are 20 inches in diameter. The engines are of the triple-expansion type, of 500 indicated horse power. This dredge has developed a capacity of 800 cubic yards per hour under favourable conditions and can pump material to a distance of 3,000 feet. The upper deck is occupied entirely with quarters for the officers and crew. The contract price of the dredge was $92,515, delivered under steam on the Pacific Coast.

Another dredge of the radial type is illustrated in Figure 34. This is a 20-inch dredge belonging to the Atlantic Gulf and Pacific Co., of New York. The illustration shows the dredge at work making a canal which is intended to restore river navigation to the city of Vicksburg, Miss. In Figure 31 is illustrated a similar dredge belonging to the same

company. In these dredges, however, the suction pipe does not swing on the hull but is mounted on a frame which has a rising and falling movement only in a well in the fore part of the dredge.

The clamshell type of dredge is found mainly along the Atlantic Coast where the conditions are best adapted for its use. It is essentially a machine for working in soft material and loading scows. It is usually anchored by means of spuds, but as these are not subjected to lateral strain due to digging, as in the dipper dredge, they may be comparatively light and yet hold the dredge from moving about in the deeper water of the coast. The clamshell type of dredge is also well adapted for digging to great depth for foundation work, etc., in which case the spuds are dispensed with and the dredge maintained in place by anchorage. A usual type of clamshell dredge along the Atlantic Coast is illustrated in Figure 38. In Figure 35 is illustrated the clamshell dredge Fin Mac Cool. This was built by the Osgood Dredge Co., of Albany, N. Y., for work at Buffalo, N. Y., where it excavated the foundations for the Buffalo breakwater in 90 feet of water and was afterwards taken to the coast via the River St. Lawrence. This dredge has a record of 140,000 cubic yards per month in ordinary soft material from 30 feet of water.

FIG. 35. CLAMSHELL DREDGE FIN MAC COOL, BUFFALO, N. Y.

In Figure 36 is illustrated a special type of clamshell largely used in California, in which the opening and closing of the bucket is by levers directly attached to the two halves. Another application of the clamshell type is seen in Figure 37, in which a long boom is used for depositing material on the shore.

I have now described the four types of modern dredges, with exam-

ples of each, but the subject is such a large one that it is impossible within the limits of a paper like this to do more than touch on salient points. Enough has been said to show that during the last five years a great improvement has taken place in this class of work in America, and that the country now has some creditable examples to point to. Much still remains to be done to remove present practice from the empirical notions of the individual to a recognised basis of good engineering. In no branch of mechanical engineering are the definite results of experience so necessary and valuable, or the theoretical ideas of the novice so likely to result in failure.

The value of powerful and efficient dredging machines as a means to accomplish large works of national importance can hardly be overestimated. Works of magnitude not thought of (or deemed impossible) a few years ago, can now be undertaken with confidence. As efficiency increases with size in the steamship and locomotive, so it does in the dredge; and with large and modern tools enormous capacity can be reached.

The great expansion which has taken place in the size of steamships makes necessary the improvement of harbours and channels all over the world. This must keep pace with the vessel improvements if the

FIG. 36. CLAMSHELL DREDGE, CALIFORNIA TYPE, VICKSBURG, MISS.
5.6-yard (struck) bucket.

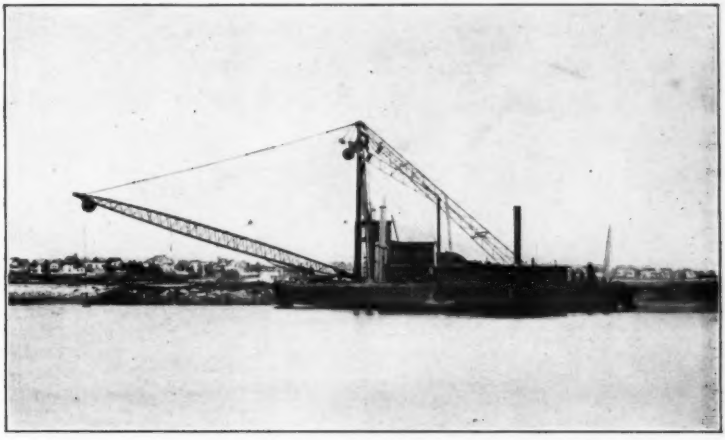


FIG. 37. CLAMSHELL DREDGE WITH LONG BOOM, NEW YORK.

best results are to be obtained, but at present it must be said that the vessels lead in the race, and it is "up to" the harbours everywhere to provide accommodations for them.

Internal waterways also occupy a large share of national attention and national expenditure, but it is astonishing how little attention is devoted to the economy represented by the mechanical efficiency of the dredging tools used in building and maintaining them. A saving of only one per cent. per yard means ten thousand dollars on each million yards of work.

The Isthmian canal is now occupying public attention, and bids fair soon to reach a stage at which actual construction will be begun. The plan and prospects are now more promising, and the prospective result more momentous, than when the brilliant scheme of De Lesseps at Panama failed so lamentably. We have not waited in vain. We have now a better knowledge of the conditions, better engineering skill with which to conquer them, and tools of which De Lesseps never dreamed available for the execution of the work.

The work situated as this is a long distance from the base of supplies, and where skilled labour is expensive, it is of great importance that machinery should be simple and strong and easily operated without manual effort. The value and importance of modern machinery of large capacity increases as the cost of labour, skilled and unskilled, increases. On the Central American Isthmus the labour question is a serious one. Native labour is inefficient, and cannot be used for any skilled

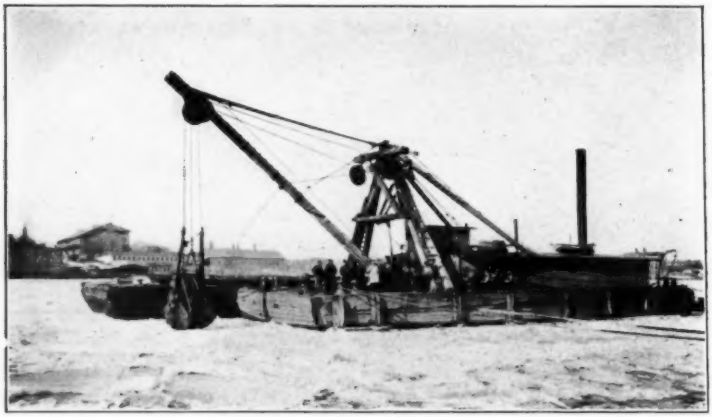
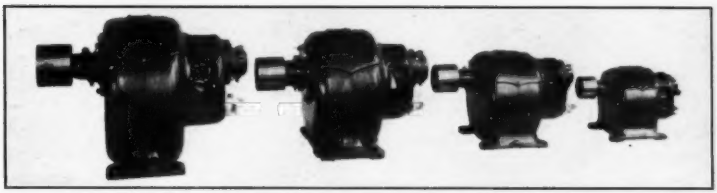


FIG. 38. CLAMSHELL DREDGE, NEW YORK.

operation. Imported labour is costly, and elaborate systems of sanitation must be adopted. Physical exertion in that climate is impossible for any length of time. Hence labour-saving devices are essential, and specially designed tools of large power and capacity must be adopted, in which the skilled man will be the brain and not the muscle.

Formerly an army of men would be necessary to carry out such a gigantic work, and the mortality inevitably large. Now it is possible to accomplish the work with powerful machinery, adapted to operate with but few men, and with proper care and sanitation the loss of life need not be large.

In these articles I have only touched upon the principal types of machinery used in this class of work and indicated in a general way the progress that is being made. For the future we may expect great advances, especially in the direction of economy of results and greater reliability in service, so that more work can be accomplished for the money and time expended than ever before. The large power and great capacity of tools now available for public works makes it not only possible, but economically advantageous, to plan them on a large and comprehensive scale. The advantage conferred by great size and power must, however, be used with great caution and skill, otherwise we will see examples of great and ambitious machines which may be first-class in the main, and yet contain errors and misfits of design that may entirely nullify the benefit to be derived from the otherwise general excellence.



THE DEVELOPMENT AND USE OF THE SMALL ELECTRIC MOTOR.

By Fred. M. Kimball.

Mr. Kimball's entire professional experience has been specialized upon the application of the electric motor to industrial uses. The keynote of his treatment of the subject in the articles begun this month is practical economy and commercial success. He keeps always in plain view the working conditions of the ordinary shop and the limitations of the ordinary shop workman. He meets the questions which present themselves to the workshop owner or superintendent, showing just where and how economy will be promoted by the introduction of electric driving, what points must be considered and what methods pursued in the installation of electric motors, and what effects on shop practice or organization will follow. The treatment, while primarily related to the machine shop, will have wide application to all manufacturing industries. The second article, in our May issue, will deal with the practical effects of "The Electric Motor in the Machine Shop."—THE EDITORS.

ALTHOUGH the public is fairly acquainted, in a general way, with the uses of electricity, it has little idea of the vast number of specific applications to which this intangible but most potent force has been applied. Neither does it comprehend very clearly the construction of the apparatus by which the power of electricity may be made manifest.

About the first commercial application of electricity on a large scale was known to the public in the form of the telegraph. Afterward came the electric light and the telephone. Following these applications the employment of electricity as a means of distributing and utilizing power was widely heralded. The operation of street cars by means of electric motors has probably been the principal means of bringing the subject prominently before the people.

But few people have any intimate knowledge of the use of electricity and electric motors when employed so prominently for transportation purposes, and even fewer still realize the extent to which small electric motors are used in connection with the thousand and one affairs of our daily life.

We find them everywhere, regardless of geographical location, and used in connection with almost every commercial, domestic, and manufacturing purpose, as well as contributing to the means of our pleasure and recreation. An attempt to indicate all the principal lines of industry in which small motors are now successfully employed would require the preparation of an article which would extend into volumes

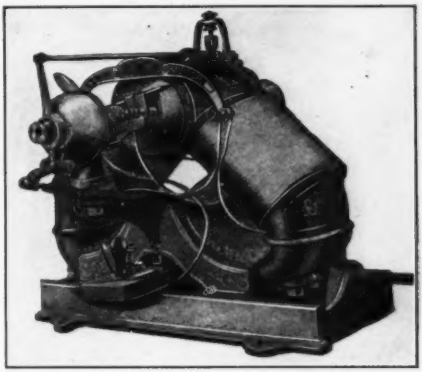
Up to the early 80's, the electric motor was considered rather more as a toy or an interesting piece of experimental apparatus than as a machine which would later revolutionize existing methods of producing, transmitting, and distributing power.

We need but lightly touch on the discovery of the principles upon which the manufacturer of small motors depends, nor need we go in detail into the earlier work done by Ampère, Jacoby, Faraday, Siemens and others. We cannot, in justice, however, proceed without at least mentioning the valuable contributions which they made to the art.

Faraday's grand discovery of the convertibility of generators into motors, and *vice versa,* was made in 1831. In 1832 Pixii in France designed and built his magneto-electric generator, which was a very distinct advance in the way of practicality over anything previously achieved. In America Charles G. Page of Salem constructed in 1835 a magneto-electric generator which foreshadowed many of the essential principles now in use. The Siemens shuttle armature with the two-part collector was brought out in 1856.

A large number of scientists and investigators were adding to the sum of knowledge during the next ten years, but perhaps the most valuable acquisition was that contributed by Antonio Pacinotti, an Italian, who, in 1860, devised his toothed-ring armature which is the prototype of all iron-clad armatures so extensively used in the present day. In 1864, Pacinotti built a very satisfactory continuous-current machine. Prior to this time, nearly all of the generators had been of the alternating-current type; and just here we should note that the first generators produced only alternating currents, and one can well understand how, by perhaps a slight turn in the wheel of fortune, some inventor might have commercialized the early alternating-current generator and motor, and we should not have gone through all the phases of development which have led from the older forms through direct-current machinery and now back again to alternating-current apparatus.

Gramme, in France, showed before the French Academy in 1871 the celebrated ring-wound armature which bears his name, and this Gramme armature seems to mark the advent of the first really practical dynamos and motors, which were used for commercial purposes.

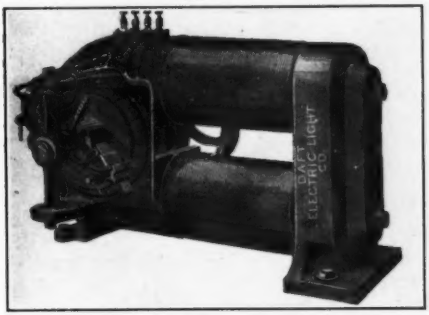


AN EARLY TYPE BAXTER MOTOR.
A historic form, used on arc-light circuits.

To one who is much interested in electrical engineering, there is no more fascinating diversion than to study the contributions made from time to time by the earlier investigators, and to peruse the notes which they left behind. The whole industry is so young that it is comparatively easy to trace, step by step, the different phases of the development of modern dynamos and motors, and to determine with a considerable degree of accuracy to whom the introduction of each vital element in design is justly attributable.

The small motor as we know it to-day is essentially a product of the most drastic evolution. When motors were first put on the market the principles of construction were comparatively little understood, and the result was that if a manufacturer could supply a machine which would not burn itself out within twenty-four hours, and which could be caused to "mote" for a few days without too many stoppages, he was pretty well satisfied.

All the early motors were supplied with copper brushes and there was a wide disagreement, often the subject of heated discussions between the agents of competing manufacturers, as to whether copper-wire brushes or copper-leaf brushes were the better.



AN EARLY DAFT MOTOR.

Many of the early motors had commutators made of brass, and sparkless operation through wide fluctuations of load was rarely accomplished; again, the zinc would burn out of the brass segments, thereby leaving the face of the commutator very rough indeed, and in-

ducing severe wear on the brushes. While theoretically a pure shunt-wound motor possesses the best elements of design for general purposes, nearly all the very early motors were series-wound. The speed regulation in the shunt-wound motor is good; its effective torque is high, and it is cheaper to build than any other motor having fair speed-regulating qualities, but its current supply must be derived from constant-potential circuits.

As arc lighting preceded incandescent lighting, constant-current circuits only were available for current supply to the motors first used for commercial purposes. Hence, nearly all of these early motors were designed for operation on arc-light circuits and were series-wound. Three of the most prominent of these motors were, respectively, the "Cleveland," "Baxter," and "Excelsior."

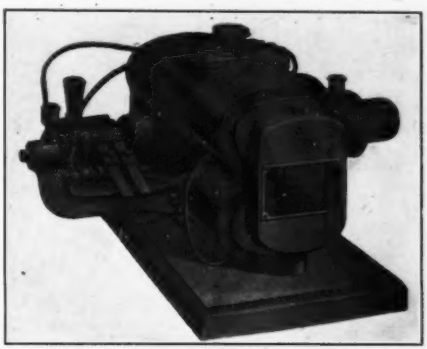
Much ingenuity was shown in the methods used for obtaining speed regulation, a very usual method being to vary automatically the number of turns in the field winding and thus increase or decrease the field strength to correspond with the load on the motor. Owing to the difficulties of effecting satisfactory speed regulation in series-wound motors, and for other causes, they were largely abandoned in favor of shunt-wound motors, except for special purposes, as soon as the constant-potential circuits needed to supply incandescent lamps became generally available.

Gramme-ring armatures were quite in favor for some of the early small motors, although a shuttle winding of the Siemens type presented less difficulties in manufacture. Drum winding was a *terra incognita* to the majority of builders. One of the prominent motors of this early day, in order that it might possess fair angular velocity and no "dead point" with shuttle winding, was provided with two armatures mounted at right angles with each other on the same shaft, the winding being led to a double two-part commutator so arranged that a single pair of brushes would complete the circuit. We should ridicule such an arrangement at the present time, but it was considered to embody a very bright idea when first put upon the market.

In the early days the proportioning of windings among themselves, or to iron, was little understood; field reactance, armature coercion, and other elements which are now looked upon as most important, received very little attention. The windings were proportioned largely with a view of keeping the heating low, and sufficient iron and wire were used to obtain what each individual producer considered to be "a good strong field magnet."

Air gaps were thought of comparatively little importance except to

give clearance, and an intimate knowledge of fluxes, while at times talked of glibly, was considered by the practical manufacturer of motors as a scientific subject which it was hardly worth his while to waste much time on. What he wanted was a motor that would "go" and not burn up, and if he obtained that he was pretty well satisfied.



AN EARLY TYPE OF SPRAGUE MOTOR WITH COMMUTATED FIELD AND HEADBOARD SWITCH. 1 horse power. This is one of the earliest forms.

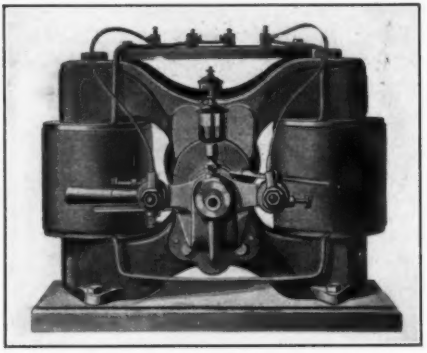
All of the motors constructed at this time were of the open type—a favorite form consisting of a base on which were mounted the magnets and pedestals for carrying the armature. Enclosed motors were not in demand, and multipolar machines had hardly been thought of. Rheostatic speed control, when any control was required, was almost universal.

Users of power in small amounts were not slow to recognize the value of the electric motor, and with the advent of more widely extended direct-current circuits on the Edison three-wire system, the demand for motors increased, and the requirements of customers became more severe so that manufacturers found it to their advantage to give a large amount of attention to improving the operation of their motors and decreasing the costs.

The brilliant work of Mr. Frank J. Sprague, about the year 1885, in producing, as a result of his own practical experiments and the theoretical investigation of himself and others, electric motors which were sufficiently sturdy in design, reliable in operation, and efficient in consumption of current to warrant their use commercially, marks one of the most important steps in the advancement of production and distribution of power supply which the last century afforded. Prior to the results achieved by Mr. Sprague, electric motors had been made, not only in the United States, but elsewhere, which were capable of operating machinery and driving line shafts. The state of perfection to which they had been brought, however, was not such as to warrant the investment of any large amount of capital in exploiting their manufacture, and their shortcomings were so great as to prevent their ex-

tensive installation as a means of driving machine tools or distributing motive power on a commercial basis.

The progress which has been attained since the year named, in the improvement of design and construction of all classes of motors, can hardly be appreciated by one who has not been intimately in touch with the subject. Suffice it to say that under Mr. Sprague's vigorous leadership, capital was rapidly attracted to the manufacture and marketing of these machines, and their uses in all classes of mechanical industries spread with a marvelous degree of rapidity.



A SPRAGUE MOTOR OF 2 HORSE POWER, EARLY TYPE.
This is a somewhat later form than the one shown on the preceding page.

The advance within the last ten years has been even more remarkable, and one can hardly mention any piece of apparatus of the size and weight, or sold for the price, which embodies the results of more painstaking work on the part of designing engineers, and the expenditure of more money on experimental account, than the small motor of the present day. Every individual part or piece of the modern, high-class, small electric motor represents the combined results of years of thought and experimental work.

A great number of drum windings have been developed and tried. The old ring winding and the shuttle winding are practically things of the past. Surface-wound armatures have given place to iron-clad or toothed armatures, and solid poles to laminated poles. Shunt-wound motors, as supplied by the leading manufacturers, approach very nearly to their theoretical possibilities, and the design of compound-wound motors may be so varied as to meet practically any requirements. The multipolar motor has been developed to a high state of perfection, and hardly any motor is considered marketable today which is not of the enclosed type. Commutators have been largely improved, both in material and construction, and carbon brushes have entirely replaced those of copper. Efficiency, too, has been vastly increased so that, according to size, from 75 to 90 per cent. or more of

the energy supplied to the terminals of the motor is easily realized in brake horse power at the pulley.

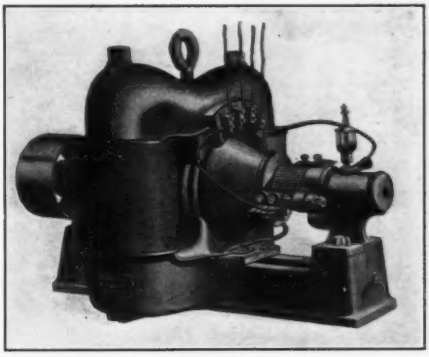
The central stations of many cities and towns, having reached the territorial limits in profitable distribution of power by direct current, have within the past two years been re-arranging their lines, adding single, two-, or three-phase circuits, and now, more than ever before, are finding uses for small alternating-current motors.

The so-called "zone system," much used in Europe, is now being widely adopted in the United States. This system makes use of two- or three-wire direct-current distribution within a circle varying in radius from one to two miles from the central station, and for outlying territory, single or polyphase alternating-current circuits are made use of. The result of these changes has been to enlarge greatly the field for induction motors, both in replacing machines which were previously operated on the direct-current circuits, formerly extending beyond the present boundaries of the inner zone, and also for the new power business which is being developed in the outer zone.

While there still is, and undoubtedly for many years will be, a large demand for direct-current motors, it seems probable that, relatively, the larger business of the future will be in motors operated from alternating circuits.

The possible users of power now located within reach of the direct-current supply have been pretty thoroughly canvassed and their requirements met. As cities and towns grow, manufacturing naturally gravitates towards the outskirts, owing to the increasing value of real estate in the centers. New industries of a mechanical nature also are more likely to locate in the outer zones than in the inner; hence, the use of alternating-current motors is now, and will be in the near future, at least, of relatively rapid growth.

With the improvements recently made in these induction motors, their use has rapidly extended and they are now



5-HORSE-POWER SPRAGUE MOTOR. AN EARLY TYPE.

Later in date of its appearance than the one illustrated on the page opposite.

A MODERN DIRECT-CURRENT 1-HORSE-POWER MOTOR WITH TERMINAL COVERS.

General Electric Co.

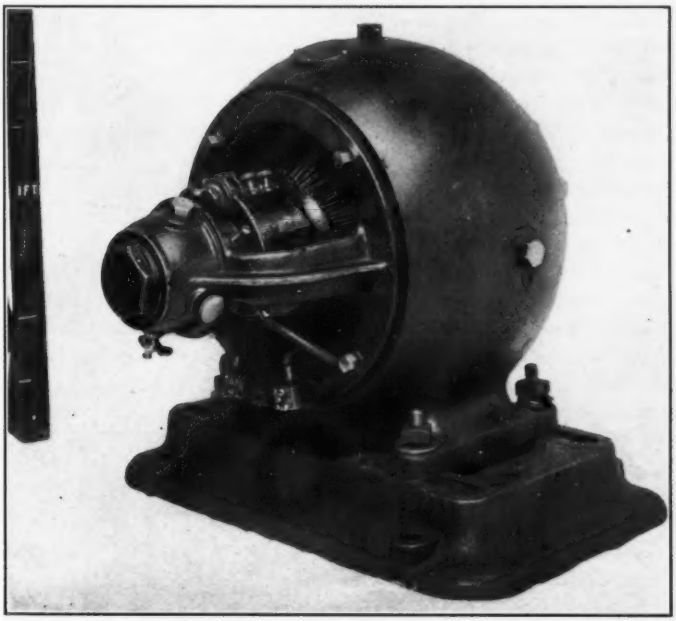
employed for nearly all purposes to which direct-current motors have been heretofore applied. In fact, the only real limitation to their use, in nearly all applications, arises from the difficulty of obtaining variation of speed. This can be accomplished, but it is a matter of some considerable expense and the results are not so satisfactory as in case of direct-current motors.

As motors have improved in quality and have been purchasable at lower prices, and central stations have multiplied over the country, distribution systems have been extended, and the cost of operating motors lessened, until they have come into such common use that the small steam engine is seriously threatened, and various oil and gas engines as well.

When one considers the enormous amount of power generated and distributed for manufacturing purposes in the United States, and then remembers that probably less than 7 per cent. of all this power is distributed electrically, he can begin to form some idea of the vast pos-

sibilities yet unrealized in the use of electrical motors. It is estimated that there are at the present time not less than 60,000 motors in daily operation in America, exclusive of those used for railways, automobiles, fans, and elevators, and these 60,000 motors—which represent an investment of about $12,000,000—are supplying something like 1,000,000 horse power. Among the more urgent reasons for the adoption of electrical distribution of power and motor drive are:

Increased production due to possibility of almost perfect maintenance and regulation of speed; saving in power supply; saving in floor space required for producing a given output; flexibility of machine location with regard to light, sequence of operations carried on, and ease of supplying the raw material and removing the finished product; elimination of dust and dirt; safety to operatives; ease and facility of adding to the existing equipment; ability to work individual machines overtime without wasting more power in operating line shafts than is consumed by the machine operated; independence of operation in each machine, i. e., freedom from a complete shut-down if a main shaft or



5-HORSE-POWER MOTOR MADE BY NORTHERN ELECTRICAL MFG. CO., MADISON, WIS.
1950 revolutions, 8.75 amperes, 500 volts, direct current.

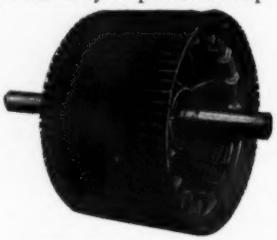
CONSTRUCTION OF A WESTINGHOUSE POLYPHASE INDUCTION MOTOR. THE PRIMARY COMPLETELY WOUND.

belt gives out; possibility of lighter roof structures—no heavy shafts and belts having to be supported—and consequent decrease in cost of building.

These are only a few of the many good and sufficient reasons for adopting electric drives. It is hardly necessary to elaborate on this point further, what has been said being fully suggestive to one studying the subject carefully.

There is no problem of more vital interest to the small manufacturer, repair-shop man, or user of light machinery, than that of obtaining a cheap, reliable, simple, and continuous source of power. This question is often the dominating factor in determining the location of a shop or manufactory. Nearly everything else is subservient to it. There are throughout the United States thousands of mechanics and manufacturers using light machinery, who are quartered in out-of-the-way, low-studded, badly ventilated and badly lighted shops, for the reason that it is only in such locations that they can find shafting to which they can attach their machines and from which they can obtain the necessary power to operate them at a reasonable cost.

Aside from the prejudicial effects to health and eyesight arising from working in such unhygienic surroundings, they are a positive and serious detriment to a man's business success. People do not like to enter gloomy, out-of-the-way, ill ventilated and dirty shops to place their orders or to look for such articles as they may be in search of. A pleasant, well lighted and well ventilated, easily accessible store or factory is an absolute necessity to any man desirous of making the most of his business. Even if a room be clean, light, and well ventilated at the start, it soon becomes gloomy and dirty if power is supplied to its occupant from the time-honored line shaft with its attendant heavy belts, frictional electricity, constant dust, and dropping oil.

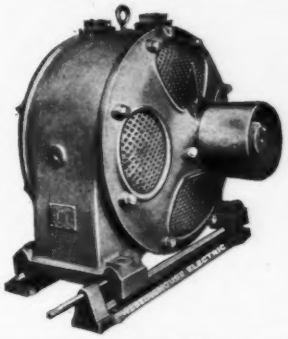


SECONDARY COMPLETE.

With the advent of the electric motor, the necessity of putting up with these conditions is largely eliminated. In all principal cities and towns, there are electric stations from which a supply of elec-

tricity may be readily obtained for operating motors. In the same cities are many well-lighted, well-ventilated, easily accessible locations for small shops or factories which could be rented at a low price and which would serve admirably as locations for small mechanics and manufacturers, did they posses the one vital element of power supply.

The electric motor enables one to locate his factory or shop wherever he desires, and by its use to have at command a continuous, clean power service available in many cases twenty-four hours per day.



WESTINGHOUSE TYPE "C" POLYPHASE INDUCTION MOTOR, COMPLETE.

With the electric motor deriving its current from a central station which supplies perhaps hundreds of customers, there is a great deal of flexibility in the matter of power supply. All of the consumers are never using the maximum at the same time; hence the station is not obliged to maintain, relatively, so large and expensive a reserve, to be paid for pro rata by its customers, as is the landlord of a building. The so-called "diversity factor" is more largely availed of. Electricity for operating the motor may be supplied through a meter which is a reliable register of energy consumed, and is as accurate as any piece of apparatus of similar nature can be. When the switch governing the motor is closed, the current immediately begins to flow, but the motor, being an automatic mechanism, takes current only in proportion to the amount of work it is doing; hence, the meter connected with it will record a charge proportional to the work actually being done.

As an illustration, take the case of a circular saw. Ordinarily a mechanic has to pay his landlord for power to nearly the full rating of the saw—say five horse power. If his business is such that he always saws hard-wood planks three inches thick, we will say, and is doing it ten hours per day constantly, then the charge which he pays is reasonable and just; but if his business is of such a nature that he only occasionally saws such a plank, more often saws half-inch pine, and perhaps for hours has his saw remaining idle, then in the case of steam he is usually paying a sum largely in excess of what he ought to pay. If his saw was driven by an electric motor, current would be charged for at the five-horse-power rate only while he was doing the

heavy work. When he was doing the light work the meter would charge up current at perhaps only one-half of one horse power, and when the saw was still, absolutely nothing would be charged up. The same argument in favor of the electric motor applies to all classes of machinery—lathes, planers, die and printing presses, sewing machines, paint mills, buff wheels, metal rollers, paper cutters, and the thousand-and-one different types of machines which are to be found among the various small shops and factories.

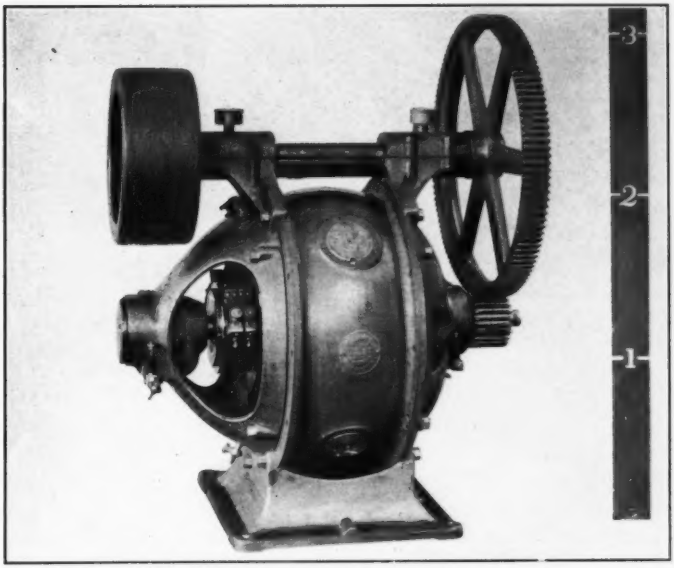
It is immaterial whether the tenant hires a room on the first, second, or third floor, or in the basement; one place is just as accessible for power as another, for wires may be run anywhere, and extension shafts, mule pulleys, skew belts, and other like power-wasting devices are avoided.

Again, each tenant in a building supplied with steam power is absolutely dependent, so far as his own power is concerned, on the operation of one engine with its attendant main shafts and belts. If any of them give out, then every tenant must stop work until repairs can be made. In the case of motor-driven machinery, the problem is entirely different. Stations are equipped with duplicate and even triplicate machinery, and a combination of circumstances is scarcely conceivable, which will deprive the customer of current; in fact, investigation will show that motors driven from central stations furnish the most reliable power obtainable.

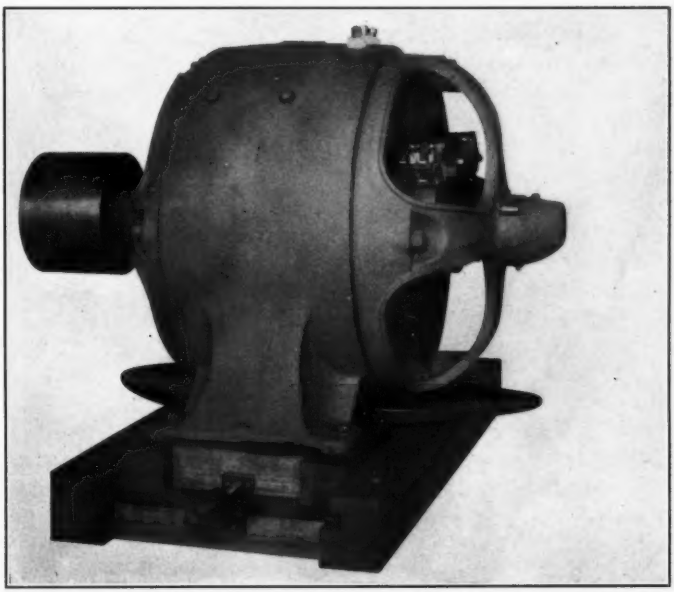
In the present day of keen competition it is necessary for tradespeople to take every advantage possible in promoting their business. The location of their warerooms or factories must be on the path of travel and easily accessible; every item of expenditure must be carefully gauged, and they must rid themselves of any charges for power or rent which are not absolutely necessary.

Central stations are, as a rule, very moderate in their charges for connecting motors to their circuits. They will run wires any reasonable distance, and will make a meter rate which is very attractive. In any event, the buyer of electric power knows to a certainty that he is paying only for power he actually uses from minute to minute, and that the size of his power bill is in his own hands. If he is careful to shut down his machinery when it is not in use, he can limit his expenses in this regard to the absolute cost of power required while the work is on the machine.

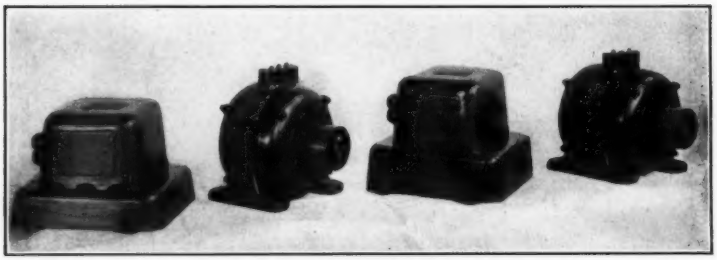
When power is supplied to machinery from an engine, it is very difficult to ascertain whether the machinery is working at its best or not, and whether there are any undue friction loads developing. If



6¼-HORSE-POWER, 230-VOLT, BACK-GEARED MOTOR.
The Jenney Electric Mfg. Company, Indianapolis.



MODERN TYPE 5-HORSE-POWER MOTOR MADE BY THE GENERAL ELECTRIC COMPANY.



GROUP OF SMALL ALTERNATING-CURRENT MOTORS WITH STARTING COMPENSATOR-CONDENSERS.

General Electric Company.

a motor is driving machinery, however, it is very easy to determine from time to time the amount of power consumed when the machines are running light, and if this amount shows a perceptible increase, it indicates at once that there is undue friction which can be easily located and the necessary remedy applied. This, in itself, is a very valuable feature of electric driving as it often discovers, especially in shops running on piece work, the abuse of lathes, screw machines, etc., by the piece workers having care of them.

The flexibility of a motor system is also of the greatest advantage. There is hardly a shop where frequent changes are not made either by putting in additional machinery, or changing the location of the existing machines. When such machines are driven by motors, it is far easier to change the wire circuits supplying them than to change a line of shafting with its attendant pulleys and belts. Furthermore, in engine-driven factories the entire location and layout has to be dependent upon the relative accessibility to, and location of, the driving shafting. This often results in the necessity of arranging the machines most disadvantageously, so far as strict regard to the sequence of operations to be carried on is concerned. Motor-driven machines, on the contrary, may be located to the utmost advantage in relation to the general layout of the factory and without regard to a line shaft. As motors may be attached to the wall or ceiling, the belts may be short and the pulleys light, causing a material saving in floor and ceiling space.

The final results of all these desirable features of electric driving and the use of motors are increased output, lower cost, higher quality of product, and larger profits.

FOUNDRY MANAGEMENT IN THE NEW CENTURY.

By Robert Buchanan.

V.—THE CUPOLA AND ITS MANAGEMENT.

Mr. Buchanan's first article appeared in our issue for December, and dealt with the general arrangement of the foundry, heating and ventilation, and the supply of tools and minor plant. His second paper discussed crane service for the foundry floor; his third, moulding by hand and machine. The discussion last month took up the specification and purchase of supplies. The concluding article, which will appear next month, will review the "Qualities and Training of the Foundry Manager."—THE EDITORS.

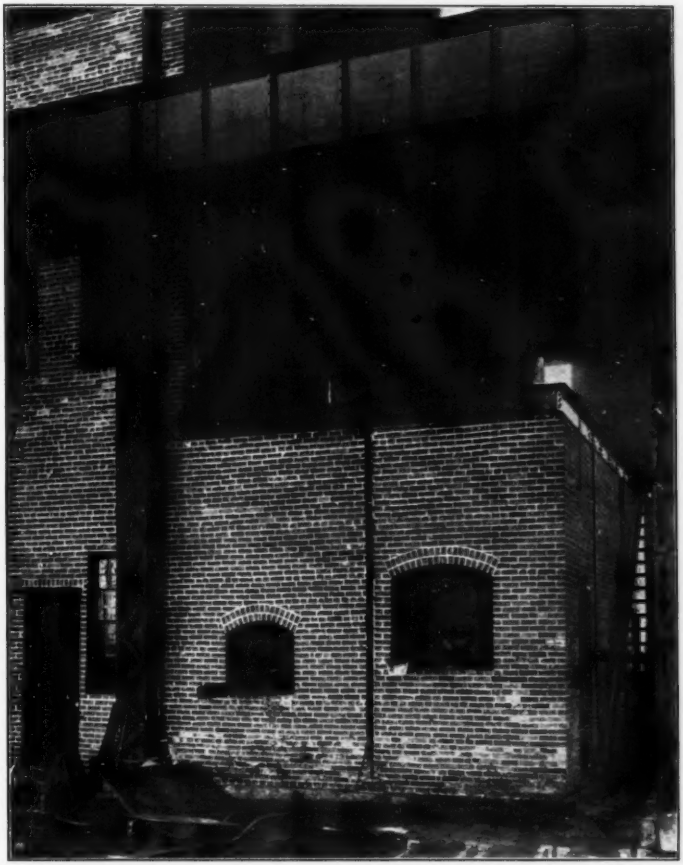
S the cupola is without exception the most important individual part of the foundry plant, a knowledge of its construction and principles of operation is of surpassing importance. The short wide cupola of thirty years ago has largely given place to a cupola of a different type. The height has been increased, and for a given melting capacity the diameter has been lessened. This has been accompanied in most cases by increased pressure of blast. With change of form has come faster melting, and decreased consumption of coke. At the same time the new type makes greater calls upon the intelligence and ability of those controlling and working the cupola. The increased height makes possible a completer use of the heat generated from the coke by utilising it in heating up the charges of iron as they descend the cupola during the process of melting. For this reason the height of every cupola should be as great as may be practicable, the limit being fixed by the facility with which the materials are elevated to the charging platform. Fourteen to fifteen feet between hearth and sill of charging door is a suitable height in most cases.

Whether cupolas be short or tall, the principle on which they melt is the same, the blast blowing onto the fuel, the iron to be melted being a certain given distance above the points of entrance of blast. The form which the cupola shall take in the region of the tuyeres down to the bottom or hearth depends largely on the class of work for which the metal is to be melted. Where light castings are the main

production and thorough mixing of the iron in the cupola of no great importance, tuyeres may be fixed at a short distance above the hearth. Such a placing of the tuyeres, however, must be accompanied by ready means of drawing slag from the cupola. Where heavy castings are being manufactured, the tuyeres must be sufficiently high to admit of the collection of a quantity of metal on the hearth of the cupola; by this practice better mixing of the metal is obtained. Proper mixing is not possible in a cupola with low tuyeres, from which the iron is carried away practically as quickly as melted. If it is desired to improve the quality of the iron still further by more thorough mixing, and at the same time have the tuyeres a few inches only above the hearth, then it is necessary to use a receiver, or fore-hearth, in which to collect the metal. This latter method, however, has the drawback of increasing the quantity of coke used on account of the receiver absorbing some of the heat generated from the coke, but under quite conceivable conditions this expenditure of fuel is permissible.

84-INCH COLLIAU CUPOLAS IN RELIANCE FOUNDRY, ALLIS-CHALMERS CO.

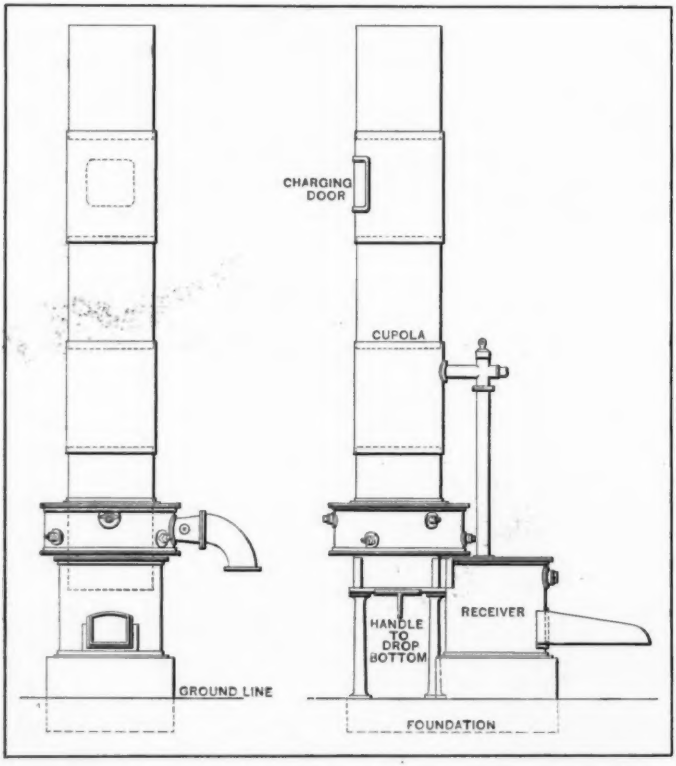
Cupolas having solid bottoms are in almost universal use in Great Britain. The drop bottom is even more universally used in the United States. The advantages of the solid bottom are that it requires only one making up, and retains the heat from the previous cast, and so does not chill the iron when melting is first begun. The principal drawback is the awkwardness with which the remaining coke and slag



NEWTEN CUPOLAS, FOUNDRY OF DETROIT SHIP-BUILDING COMPANY.

Bricked-in construction, with charging floor supported entirely by a brick wall. Front tap spout serves large crane in main portion of foundry; side tap spout serves 15-ton crane in "lean-to." Northern Engineering Works, Detroit, Mich.

are withdrawn from the cupola at the termination of the melt. The advantages and disadvantages of the drop bottom are nearly the converse of these. It requires making up each day; chilling of the first iron melted more readily takes place; but the facilities with which access may be had to the cupola, and the readiness with which the contents of the cupola may be withdrawn at the end of the cast, leave a balance of advantage in the use of the drop bottom.



HIGH-SPEED ECONOMIC CUPOLA, CHRISTY & NORRIS, CHELMSFORD, ENGLAND.

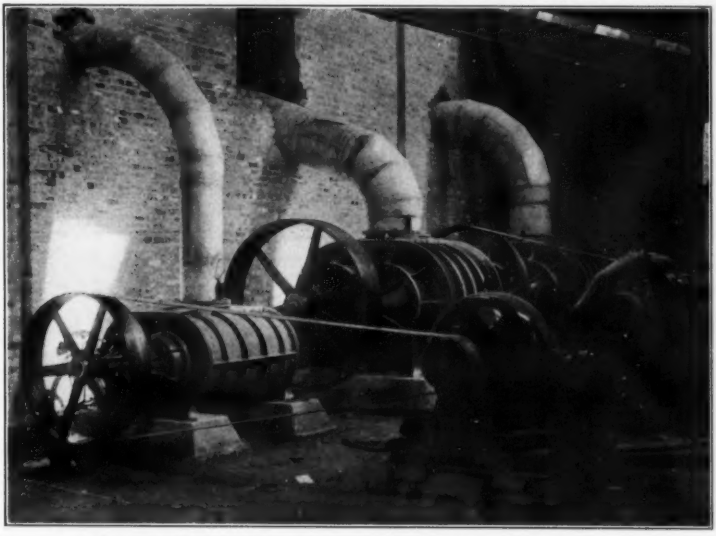
Cupola linings are almost invariably of fire bricks or other siliceous material, though Professor Turner mentions that the lining of the cupolas at the Homestead Steelworks, Pittsburg, are of mica stone in the melting zone and sandstone higher up. It is questionable, however, if science has said the last word in regard to cupola linings. The facility with which the oxides of iron combine with silica obtained from fire brick, ganister, or other siliceous material to form a fusible compound, makes it desirable that a lining free from this drawback may be available. That such a material must be neutral is certain, as basic linings have been tried and found wanting.

Coke.—In considering the quality and quantity of coke to be used in the cupola, it is most profitable to use the best quality, as regards

high carbon, low sulphur, and ash. These conditions should be accompanied by density of structure. When carbon is low, the highest temperatures are not obtainable unless a greater quantity of coke is charged. This necessitates increased quantities of fluxing materials, and if the sulphur be also high, hardening of the castings is an inevitable result.

A prejudice exists against coke made in patent ovens, such as the Simon-Carve, where the bye-products are recovered. I have used hundreds of tons of this coke and consider it equal to bee-hive oven coke in everything but appearance.

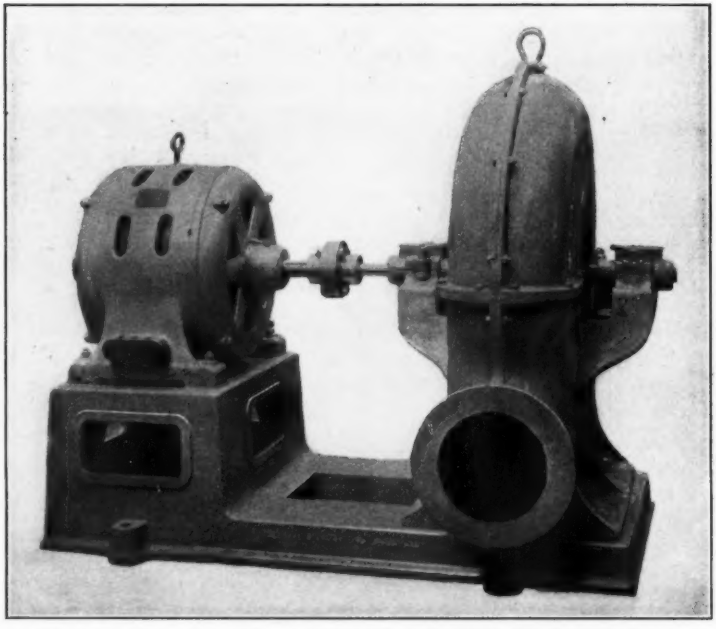
In comparing one foundry with another regarding the consumption of coke per ton of metal melted, it is well to bring into consideration the quality of the iron melted. It is misleading to compare the melting of iron high in phosphorus with the melting of low-phosphorus iron, owing to the facility with which the former may be brought to a very fluid condition. Low-phosphorus iron always requires a greater quantity of fuel to melt it, the quantity increasing as the percentage of phosphorus decreases. It is important to keep a thorough record of the consumption of coke, and to have a means of checking the records so that the best results may be obtained at the cupola. These, and the records relating to the charges of iron going into the cupola, are worse



BLOWER ROOM IN WEST ALLIS FOUNDRY, ALLIS-CHALMERS CO.

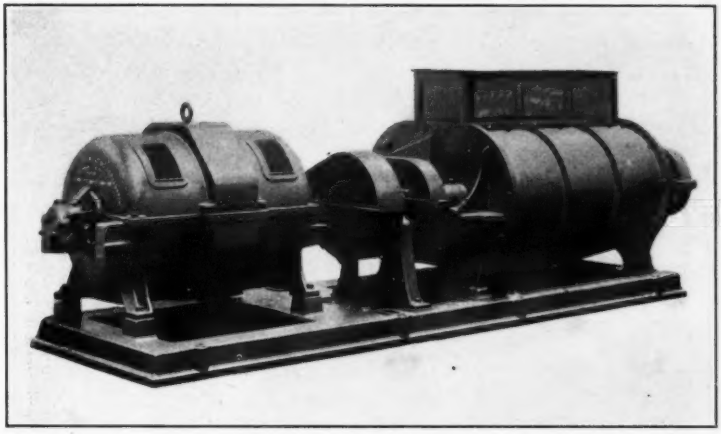
than useless if not accurate. Should there be no records, or no checking of records where they exist, melting is sure to be costly and mixing not well done. Be not over-anxious to save coke. The great consideration is to produce metal suited for the work to be cast. If that is not being done then saving coke is not economy. Almost all wonderful records in melting are merely got up as records. If during a year's work one has been melting from 7½ to 8 pounds of iron with 1 pound of coke, then it may be considered satisfactory.

Some years ago cupola mixtures were almost wholly made up by the manager or foreman from brands of iron which were known to him by experience or reputation. This way of mixing is not by any means extinct yet, but happily its days are numbered. We have now come to a time when more exact knowledge is available regarding the quality, nature, and effect of irons possessing certain characteristics, and these may be enlisted so as to form a fairly definite compound. It is in the nature of things that the foundryman who contents himself with the weapons of fifty years ago should be at the mercy of the



MOTOR-DRIVEN CUPOLA FAN, ALLDAYS & ONIONS, BIRMINGHAM, ENGLAND.

competitor who can bring to his aid the science and knowledge of to-day. If one would use the newer aids to accurate and economical working, he must know, so far as the science of the time has reached, the effect of the various constituents to be found in iron and how they affect the quality of the iron. It is not possible with the space available to give any extended notice to this aspect of the question, but briefly to indicate the outstanding features.

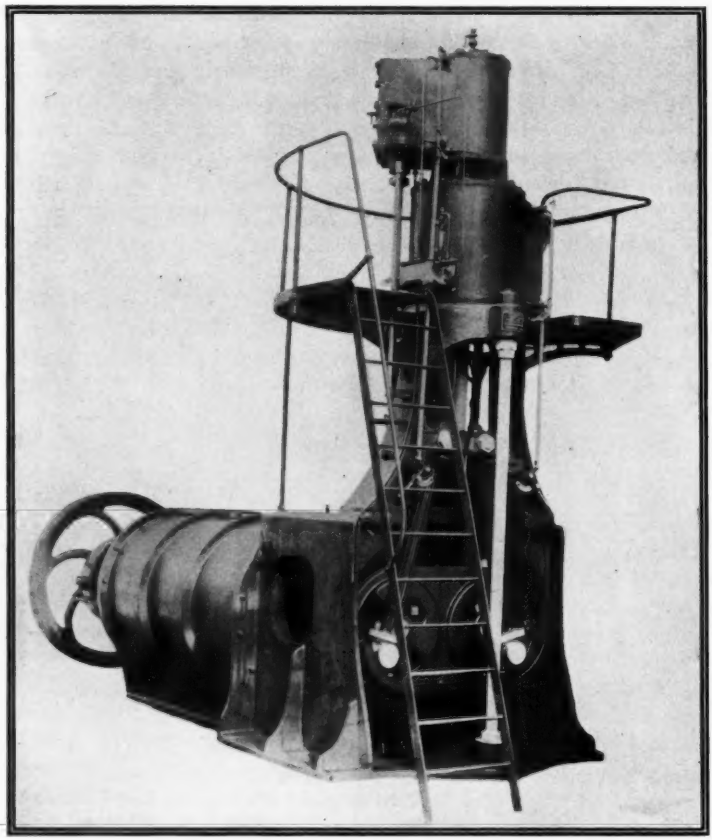


ELECTRIC-DRIVEN ROOT BLOWER FOR CUPOLA BLAST. SAMUELSON & CO., BANBURY.

In making up mixtures of iron it is necessary to bear in mind the class of castings for which the metal is intended. If light castings are the class being manufactured, and appearance rather than strength is desired, then phosphorus may reach as high as 1.5 per cent. When phosphorus is under 0.80 per cent. the metal is less fluid and does not give such a fine skin to the casting. Such a casting will sustain shock much better than one with higher percentages of phosphorus. Silicon may be over 3 per cent. and should not be under 2.4 per cent. Sulphur should not exceed 0.10 per cent. in the casting. Manganese may reach 1 per cent. and total carbon should be the highest obtainable. Irons which are high in silicon almost invarably have low sulphur and low total carbon.

In castings 1 to 1½ inches in thickness which are to have strength and good working qualities, silicon may run to 2 per cent., phosphorus 0.40 per cent., sulphur 0.10 per cent., manganese up to 1 per cent., combined carbon 0.4 to 0.5 per cent., the remainder being graphitic carbon.

For heavy castings of the highest quality, silicon may be 1.20 per



ROOT BLOWER DIRECT-COUPLED TO COMPOUND ENGINE.
Samuelson & Co., Ltd., Banbury, England.

cent., phosphorus 0.20 per cent., sulphur not exceeding 0.10 per cent., manganese up to 1 per cent., combined carbon 0.60 per cent., the remainder being graphitic carbon.

To obtain these percentages, the analysis of the various pig irons forming the mixture must be available. These, with the scrap, may be combined in such proportions as to give almost any necessary result. It is to be noted that however well metal may be mixed, either in charging into the cupola or afterwards when melted, certain changes have taken place in the course of melting which must be taken into

account. In the course of one melting, silicon will decrease by about 0.25 per cent., manganese decrease by 0.10 per cent., and sulphur increase by 0.038 per cent. Phosphorus usually remains unchanged by melting. If any change does take place it is by increase, as the blast oxidises iron more readily than phosphorus.

Whether total carbon be increased or decreased in the course of melting depends largely on the amount of coke used in the cupola. When the coke is down to a fine point, simply doing its work and no more, there is a great likelihood of the blast oxidising the carbon in the iron (and sometimes the iron itself) to a considerable degree. Under such conditions, the carbon is decreased. On the other hand, full charges of coke take up in a greater degree the oxygen of the blast, and so the carbon of the iron, and the iron itself, are less subject to oxidation. Under these conditions it is quite possible to have an increase of total carbon in the castings produced. It may be noted that silicon and manganese are still more readily oxidised than the carbon present in the iron.

It is important to remember that hot melting and hot pouring give the best results in quality of iron. The difference in strength of two test bars of similar area, one cast hot the other cast dull, may be as much as 12.79 per cent.* A high temperature in the cupola has the effect not only of making fluid iron, but also of making fluid slag. The high temperature and fluidity of the slag increases its capacity for absorbing sulphur. Such an affinity does not obtain when the temperature is low, a "low" temperature meaning one which produces melted iron of a heat not higher than the "red molten" condition. At such a temperature the affinity of the slag for sulphur is less than that of iron at a similar temperature, and so the sulphur of the coke almost certainly goes into the iron with disastrous results to the product. If the slag and iron be allowed to cool in contact, not only will the iron retain the sulphur it originally had, but it will absorb the greater part of the sulphur present in the slag. Hot melting, and ladles free from slag, are thus of prime importance.

The following points regarding cupola condition and management may be worth noting:

Double rows of tuyeres deepen the melting zone, and increase the speed of melting. If three rows of tuyeres be used the upper row rapidly wastes the lining. The combined area of the tuyeres should not exceed one-tenth the area of the cupola at the melting zone. As the area of the cupola increases so should the blast pressure, that the

* See "The False Witness of the Test Bar," THE ENGINEERING MAGAZINE, May, 1902.

cupola may melt at the centre, as well as in the region immediately over each tuyere. Sloping the tuyeres downwards has no advantage unless it be that if they fill with slag or iron they will empty themselves into the cupola at next tapping. Tuyeres which fill with either slag or iron prove bad design or bad management. If the coke is soft, decrease the pressure of blast and increase the tuyere area. If the coke is dense and hard, use high-pressure blast. Twelve to sixteen-ounce blast may be considered high pressure in ordinary foundry practice. Four to six-ounce is low pressure, and will melt hot though slowly. When using high-pressure blast, the bed of coke should extend from 18 inches to 24 inches above the highest tuyere. Using low-pressure blast, if the bed of coke be 12 inches over the upper tuyere, that is enough. The wear of the lining at the melting zone will indicate the height the bed should be. Melting takes place in a definite part of the

LOWER END OF SKIP INCLINE FOR CUPOLA-CHARGING APPARATUS, WEST ALLIS FOUNDRY OF ALLIS-CHALMERS COMPANY.

cupola which we call the melting zone. Iron melts there and there only. The melting zone seldom exceeds 36 inches above the highest tuyere. Coke in excess of the quantity necessary for a bed the proper height is simply burnt away without doing any melting. Coke between the charges of iron should just be sufficient to replace that part of the bed consumed in melting the previous charge of iron. The bed is thus kept regular in height, and the melting is regular both in speed and temperature. If the charges of coke are too great the flame from the

HYDRAULIC CUPOLA HOIST, R. D. WOOD & CO., PHILADELPHIA.

cupola is a whitish-yellow colour, wreathing in "oily" folds as it stretches up and out of the cupola stack. The proper flame, if flame there be, ought to be a bluish-pink colour, and have a ragged and torn appearance, as it clings to every projection about the charging door. The heat at the charging door should not be greater than a dark red. A black heat is better still. When lighting up the cupola see it is not lit too early. It requires to be kindled to the top of the tuyeres; every minute after that is reached and blowing not begun, fuel is wasting.

WEIGHING MACHINE FOR SECRET CHARGING OF THE CUPOLA.

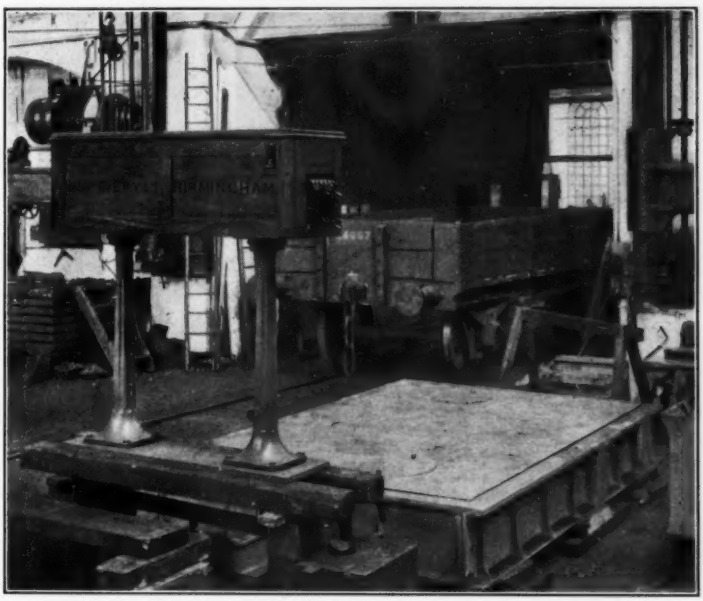
One steelyard is used for taring the barrow or other vehicle; the other five, or any number of them, may be used for the several irons forming the charge. The poise on each steelyard is adjusted by the one responsible for the mixture, and the enclosing box is then locked as shown on page 61. Charging is thus both secret and accurate.
W. & T. Avery, Ltd., Birmingham.

Do not keep the cupola standing charged for one or two hours. At kindling time when the fire is at the top of the tuyeres, charge up to the charging door, then begin to blow.

Pig iron high in silicon is now used in many foundries for the purpose of controlling the condition of the carbon in the castings. Silicon has the power to prevent the carbon in cast iron taking the combined or hardening form, by causing it to take the form of graphite. Silicon, if present in cast iron to the extent of 5 per cent. or over, has also the power to diminish largely the absorbent capacity of iron for carbon, and this increases with the increased percentage of silicon. Thus high-silicon irons are always low in total carbon. In this respect silicon and manganese differ, manganese increasing the capacity of iron to absorb carbon. Silicon also tends to neutralise sulphur present in cast iron. When Professor Turner of Birmingham University made the important discovery of the influence of silicon on cast iron (a discovery which some who had nothing whatever to do with it seem not disinclined to share with him), many foundrymen had the idea that the days when illimitable scrap could be made into soft castings had

come. This proved a disappointment to many, and the reason for this is perceivable in the light of later knowledge. Scrap iron is often rusty, and so its oxides tend to lessen the total carbon, and as siliceous pig iron is also low in total carbon, the resulting metal tends to cause drawing or sinking in the castings. While the excessive use of scrap is not advisable for the reason given, the knowledge of how and to what extent softeners may be used is valuable. Silvery or "silky" iron may often be bought at prices under those of ordinary No. 3 iron. This "silky" iron has sometimes as much as 5 per cent. of silicon, and is used to bring to a proper average the silicon contents of scrap or pig iron low in that element. Thus by using three cheap irons, each of an off grade or low number, excellent iron may be produced.

The use of steel scrap for the purpose of strengthening cast iron is favoured by many foundrymen. That steel will strengthen some mixtures of iron is true; that it will strengthen all qualities of iron is not true, neither does it strengthen any mixture in the way it is too often supposed to do. There is an idea that the addition to cast iron of such a strong material as steel imparts to the mixture some of the qualities of steel. When one considers, however, that steel is a metal whose



WEIGHING MACHINE FOR SECRET WEIGHING, LOCKED UP AND READY FOR USE.

qualities arise from the very definite percentages of iron and carbon forming the alloy, it follows that with a variation of composition, such as is found in cast iron, a very different material is formed. If steel had the strengthening effect which many believe it to have, then it would strengthen all mixtures of cast iron; but this we know it does not. Let us take 900 pounds of pig iron of a certain analysis and add to it 100 pounds of "mild" steel. The percentage composition will be:

	Pig Iron	Mild Steel
Silicon	2.333	0.047
Phosphorus	.413	0.035
Sulphur	.040	0.034
Manganese	.462	0.360
Comb. Carbon	.420	0.211
Graphitic Carbon	3.180	—
Iron	93.152	99.313
	100.000	100.000

The percentages in the mixture are as follows:

		Silicon.	Phos.	Sulphur.	Mang.	Comb. C.	Gr. C.	Iron.
Before melting		2.104	0.375	0.039	0.451	0.399	2.862	93.768
Changes during Melting	Gain	—	—	0.038	—	0.100	—	—
	Loss	0.250	—	—	0.100	—	0.100	—
After melting		1.854	0.375	0.077	0.351	0.499	2.762	—

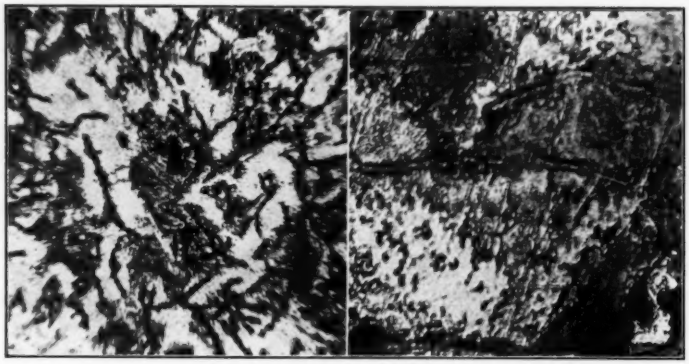
For 1,000 pounds of such a mixture put into the cupola not more than 920 pounds would reach the ladle. The gain in sulphur is such as results from using coke with 0.77 per cent. of sulphur and the combined carbon is increased by 0.10 per cent. because of increase of sulphur and decrease of silicon. To those who understand proper methods of mixing and have a variety of irons to choose from, it is not difficult to produce, solely by the use of cast iron, results superior to those obtained by such a use of steel scrap. Such a mixture as that just shown is easily reproduced without using steel, and the drawbacks attaching to the use of steel are avoided.

THE CRUCIBLE FURNACE IN WHICH PROF. TURNER MADE HIS DISCOVERY OF THE INFLUENCE OF SILICON ON CAST IRON.

THOMAS TURNER, M. S., A. R. S. M. PROFESSOR OF METALLURGY AT THE UNIVERSITY OF BIRMINGHAM, ENGLAND.

Discoverer of the influence of silicon in cast iron.

Where irons are high in silicon and graphitic carbon, steel may be used to lessen silicon and so increase the combined carbon. In this way only does steel strengthen cast iron. When steel is charged into the cupola along with cast iron, how much of the steel reaches the ladle is always a doubtful question, owing to the excessive oxidation which the steel undergoes during its passage down the cupola. If steel is to be used, the best plan is to have it in a finely divided state, such as punchings or turnings, these being added to some of the metal already in the ladle. the remainder of the iron being tapped on the top of it. Brisk stirring of the metal helps to dissolve the steel. The principal objection to this



MICROGRAPHS OF IRON FROM THE BEAM OF A PUMPING ENGINE CAST BY JAMES WATT.
Left, 100 diameters; right, 500 diameters.

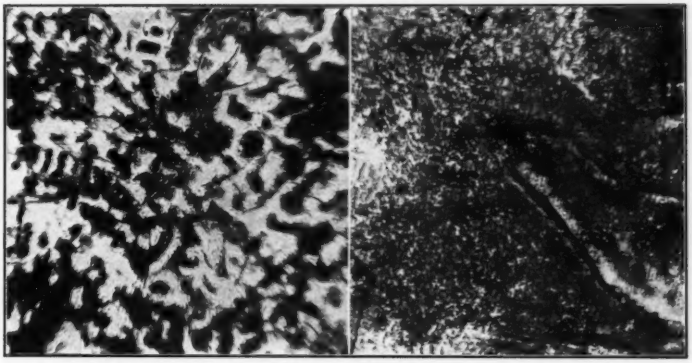
course is the liability of steel not thoroughly absorbed by the iron forming hard spots in the castings.

Physical Structure of Cast Iron.—To shew the physical structure of cast irons of high quality, six photomicrographs illustrating three irons are shown. These have been prepared for the author by Mr. A. E. Tucker, F. I. C., F. C. S., Birmingham, who also has done almost all the detailed analyses in this series. These photomicrographs are prepared by polishing a section of each metal until not a trace of a scratch remains. The section is etched with dilute nitric acid to shew up the structure, and is then photographed while in the microscope. The photomicrograph thus represents to all what the individual eye would see if viewing the section by means of a microscope.*

The first two photomicrographs shew a piece of cast iron magnified 100 times, and the same piece magnified 500 times. That iron was cast by James Watt, more than 100 years ago. It is from the beam of a pumping engine, which worked for nearly 100 years and latterly came back to the Soho foundry as scrap to be remelted. The photomicrographs are accompanied by a chemical analysis, and linked as they are with the historic name of James Watt should prove of considerable interest.

	Analysis. Per cent.		Analysis. Per cent.
Silicon	1.073	Manganese	0.321
Phosphorus	0.658	Combined carbon	0.211
Sulphur	0.082	Graphitic carbon	2.120

* For full details as to the preparation of sections of many kinds of metals and what the etched surfaces convey, see Hiorns' excellent "Manual of Metallurgy" (Macmillan).

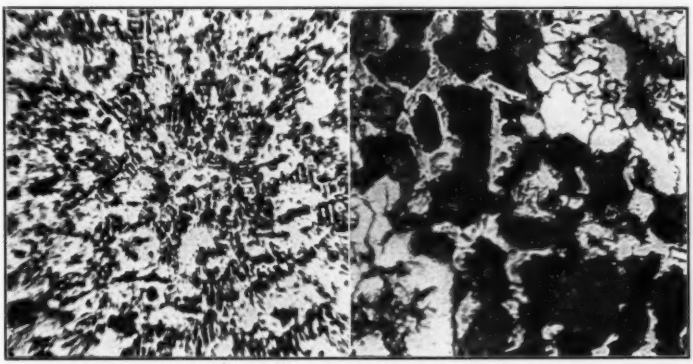


MICROPHOTOGRAPHS OF STRONG CAST IRON, 100 AND 500 DIAMETERS.

The second pair of photomicrographs are those of a strong cast iron of which a test bar 2 inches by 1 inch on supports 36 inches apart had a deflection of over half an inch and fractured at 37½ hundred weight (4200 pounds). This equals 3150 pounds for a test bar 1 inch by 1 inch at centres 12 inches apart.

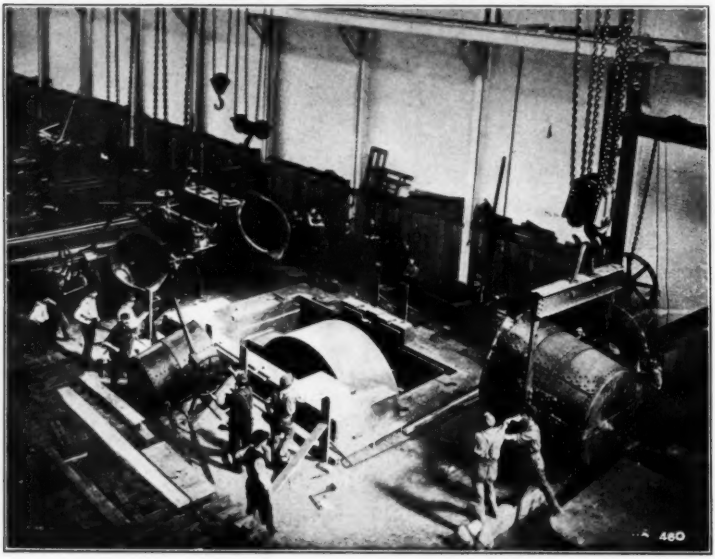
The James Watt iron already shewn formed seven-tenths of the mixture, and it is interesting to observe in the modern iron the reproduction in an accented form of some of the markings to be seen in the older iron. The analysis was:

	Per cent.		Per cent.
Silicon	1.119	Manganese	0.522
Phosphorus	0.692	Combined carbon	0.670
Sulphur	0.108	Graphitic carbon	2.860



MICROPHOTOGRAPHS OF CAST IRON FOR LIGHT CASTINGS, 100 AND 500 DIAMETERS.

The third pair of photomicrographs shew the structure produced by a first-class mixture for light castings about one-eighth of an inch in thickness. The black splatches in the one magnified 500 times are flakes of graphite and exemplify what makes a casting "soft." When boring or filing has to be done these flakes of graphite act as so many partings betwixt the granules of iron and so assist their separation.



FOUNDRY REHEARSAL, WESTINGHOUSE MACHINE CO. PREPARING FOR POURING A HEAVY CASTING.

Along with the analysis of the soft iron just shewn are given the equivalents of the constituents in pounds and ounces. To emphasise the importance of keeping sulphur low it may be mentioned that were the sulphur increased to 2½ ounces the metal could not be bored.

Analysis of iron in photomicrographs (3)	Per cent.	Weight of constituents in 100 lb. of cast iron as analysis on left. lbs.	oz.
Silicon	2.61	2	9½
Phosphorus	0.79	—	12½
Sulphur	0.09	—	1½
Manganese	0.47	—	7½
Combined carbon	0.19	—	3¼
Graphitic carbon	3.12	3	2
Iron	92.73	92	11¾
	100.00	100	0

Fluxing the Cupola.—Every flux which is used in the cupola has lime as one of its constituents. These fluxes are used for the purpose of combining with the sand or other material which it is desired to keep separate from the metal, and by forming a separate body, which we call slag, this result is obtained more or less successfully. There is a point, however, where an excessive use of lime will cause the slag to decrease in fluidity, but that is not a common occurrence.

Limestone is the flux most commonly used, and is certainly the cheapest unless the circumstances or position of the foundry are of an exceptional kind. Fluor spar, a compound of lime and fluorine, is much recommended as a flux having powerful effects towards reducing the percentages of sulphur and phosphorus in the iron, with a commensurate increase of these elements in the slag. I have made trial as to the powers of fluor spar in this direction, and the results bear out only in a minor degree the claims made in its favour.

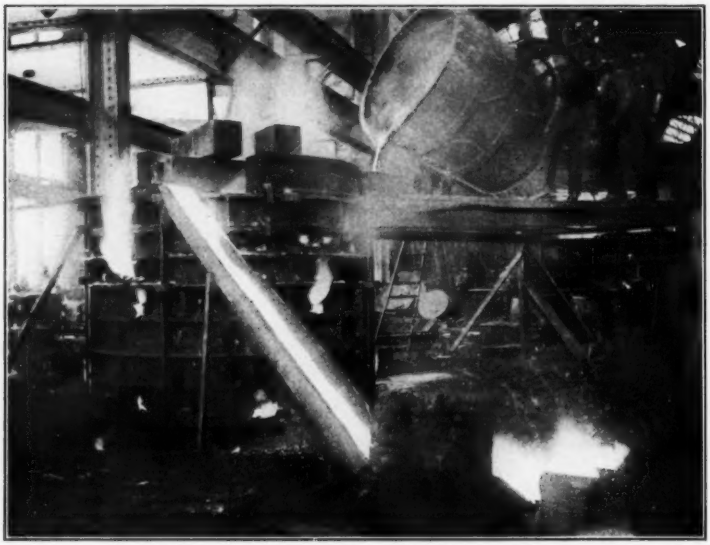
Cupola Slags.

	Average of four meltings using 48 pounds limestone per ton of metal melted.		Average of six meltings using 42.8 pounds of mixed limestone and fluor-spar in proportion. Limestone ..... 81.50 per cent. Fluor-spar ..... 18.50 per cent. 100.00	
	Per cent.		Per cent.	
Silica	57.23		55.38	
Alumina	9.15		8.40	
Oxide of iron	7.85	(=iron 5.50)	7.97	(iron 6.19)
Lime	22.61		23.20	
Manganese oxide	2.78		4.46	
Sulphur trioxide	0.28		0.45	
Phosphorus pentoxide	0.07		0.11	
	99.97		99.97	

A mixture of limestone and fluor spar was used, as fluor spar by itself is much too expensive. The mixture cost 12 shillings 8 pence per ton as against 6 shillings for limestone. What was gained was an increase in the slag of sulphur trioxide (SO_3) from 0.28 to 0.45 per cent. and of phosphorus pentoxide (P_2O_5) from 0.07 to 0.11 per cent. The increase of sulphur in the slag was about one and one-tenth ounces per 100 pounds of slag—not an inconsiderable amount. As a dephosphoriser fluor spar is a failure. A drawback to the use of fluor spar is the pungent gases coming from it affecting the eyes and lungs of the men about the cupola. What is in its favour is the nicely fluid slag it forms.

Iron Lost in Melting and Handling.—The percentage of "gits" and other returned scrap, including "wasters," has a material bearing, not

only upon the cost of production generally, but also upon the amount of iron lost in the course of melting. This percentage will vary according to the class of castings made, and the standard of quality to which the castings must attain. It is thus difficult to say whether a certain percentage of returned scrap is or is not excessive. A foundry making medium to light castings of high quality will have returned



POURING A CROSS-HEAD GUIDE, WESTINGHOUSE MACHINE CO.

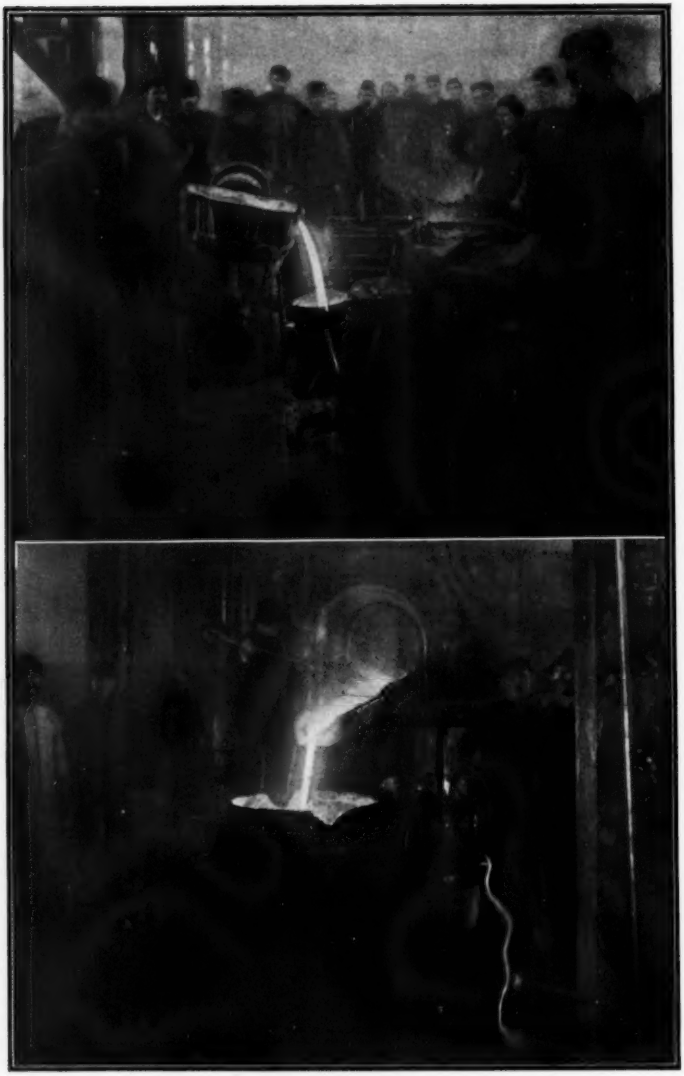
scrap, including "wasters," of 24 to 26 per cent. of the weight of good castings made. In a foundry making light castings wholly, the returned scrap may reach 44 per cent. as an average. These percentages are from actual foundry practice. In the latter case the amount of iron lost in melting in the course of a year will be considerably in excess of the other. The loss in melting in a foundry manufacturing a given class of work is no criterion whatever as to the loss which should obtain in other foundries, unless they be engaged in exactly the same class of work. There is great difficulty in ascertaining what the exact loss of iron in any foundry is, including as it does loss in melting and loss as "shot iron." The loss of iron in a foundry making castings of medium size, using "bought in" scrap as part of the mixture, may be taken as running from 8 per cent. to 9 per cent., the scrap naturally causing a greater loss than should obtain in foundries using

all pig iron and their own scrap. In foundries making light castings, where the returned scrap reaches, as I have stated, to somewhere about 44 per cent., the loss will be in excess of this, readily reaching to over 11 per cent. To keep the loss in melting to the lowest point possible, see there is proper charging of the cupola with coke, so that the oxidation of the iron by the blast is reduced to the lowest degree possible; proper fluxing, so that the iron combines with the ash of the coke in only the smallest percentages; and proper adjustment of the quantity and pressure of blast. If high pressure of blast be used in cupolas of small diameter, liability to waste in melting is increased. Under no circumstances whatever is it possible to take as much iron out of the cupola as is put in. To test if the loss is normal analyse the slag for oxide of iron. If this reaches 10 per cent. it wants seeing to.

The transport of the metal when it is melted is coming day by day to be considered well worth the attention of foundry men. In foundries doing heavy work, fewer changes have taken place in recent years than have obtained in light foundries. The heavy foundry still depends upon the crane as the means of transport. In these days of responsibility of employers for the supply and use of safe tools, the screw ladle is a factor of safety, leaving out of view altogether the duty of employers to reduce to a minimum the risks of their workmen. No ladle whatever having a capacity of over 10 hundred weight should be without screw gear.

Where foundries are large and moulds are numerous, the trolley or bogie ladle becomes a necessity. Many foundries are adopting in their place ladles suspended from overhead tracks, but it is not every foundry which can afford to have the upper spaces impeded by a trolley track. It is the exception to have a foundry where floor tracks are unsuitable. One cause of objection to trolley ladles running along the floors lies more in the character of the ladles themselves than in the rails or ways along which they run. The desire for ladles which will turn in a small radius in many cases has resulted in ladles being made of dubious stability. Wheels

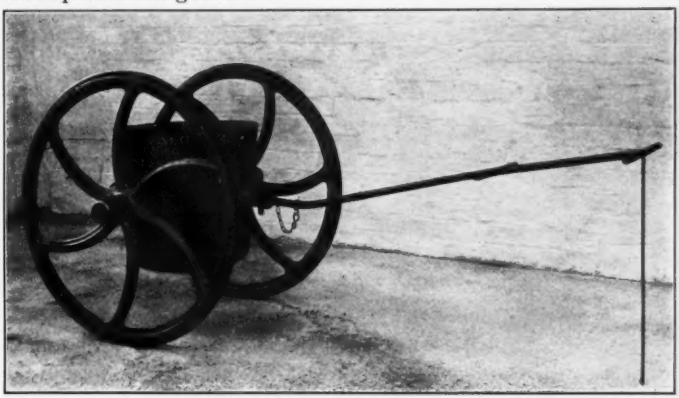
A BAD TYPE OF TROLLEY LADLE.



LADLE CAR REVOLVED BY SELF-LOCKING CAM GEAR. FOUNDRY OF THE GENERAL ELECTRIC CO.

Height of top above rail, 36 inches. Pours into hand ladle 17 inches high. The ladle moves steadily in the same direction as the handles, but only one-twelfth as fast. Remains locked in any position. Capacity 1,500-3,000 pounds. The C. W. Hunt Co.

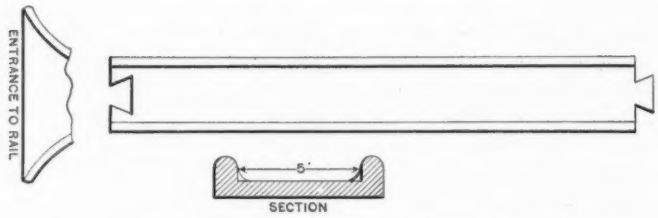
are made of small diameter so that when the ladles are tipped the lip shall not foul the circumference of the wheel. On page 69 is an illustration of a ladle which will turn in a small circle, but it is difficult to draw and is unstable. A very much superior trolley ladle is one mounted between two large wheels, the centre of gravity of the ladle being lower than the centres of the wheels. From the size and form of the wheels these are sometimes called "sulky" ladles. These wheels, being without flanges, run on rails or tracks as shown in the illustration on the next page. This ladle turns in a comparatively small circle, is easily pushed or drawn along, and is absolutely safe. The hand ladles are placed between the rails, pouring being readily done from either lip of the large ladle.



SULKY LADLE MUCH USED IN SCOTCH FOUNDRIES.
Charles McNeil, Jr., Kinning Park Ironworks, Glasgow.

The ladle car shown on the facing page has some very good features, particularly the tipping arrangement, by which the ladle may be left at any angle, without risk of upsetting. The particular arrangement and design, however, necessitates the use of four wheels; this again involves the use of a turn table at all crossings in the foundry, but these are now being widely introduced in connection with the "industrial railway" transport system. The use of trolley ladles has the advantage of reducing the amount of iron poured out by those using hand ladles, as any iron remaining in the hand ladle is poured back into the trolley, and waste is thereby avoided.

Regarding hand ladles themselves, there is little difference between those used in different countries, most of them being made of stamped steel. These are admirable for their lightness, which is an important



RAIL FOR TWO-WHEELED TROLLEY OR "SULKY" LADLE.

feature where much hand-ladle work is done. In some places a short cast-iron body is used, and on the upper part of it is fastened a sheet-iron rim, which is renewed should it get burnt away. Others use the body wholly of cast iron. These are cast bottom upwards, having no top part on the mould, so that should the bottom "blow" or "scab" a little, no harm is done. This has the disadvantage of being heavier than the other two forms mentioned, but has the advantage of being cheaply made, and when burnt through or cracked is melted up again with practically no loss.

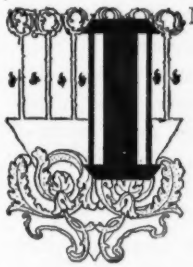
Recovery of Shot Iron.—The recovery of scrap so small as to pass through a half-inch riddle has received some attention in recent times. This is done mostly by means of magnetic separators. These are very likely to cost as much to operate as the iron recovered is worth. They may cost more. When one considers the transport of the material containing the iron to the separator, the feeding of it into the separator, and the further transport of the separated iron and dirt, it is difficult to see where the profit is to come in. This leaves out of view the cost and up-keep of the separator itself, and the power necessary to operate it.

It is well to avoid the confusion of idea that because it pays well to recover brass drippings and skimmings, therefore it will also pay to recover shot iron. The latter is worth only about one-fortieth as much as the former, and this low value renders the game not worth the candle.

THE GENERAL PRINCIPLES OF MINE ACCOUNTING.

By E. Jacobs.

The mine accountant and the mining engineer—the one solving the commercial problems and the other the physical problems which once made mining little better than a gamble—have put it firmly upon a plane where it is justly entitled to the name of an industry. The engineer preceded with exact methods ot exploration, calculation, and working; but the accountant is his indispensable coadjutor in the determination and interpretation of results. Mr. Jacobs defines the scope, the functions, and the basic principles of the science of systematic record as applied to the mine. It is an important element of that modern movement which has changed the very conception of the working of a mineral deposit from a "venture" to a "proposition."—THE EDITORS.



IN view of the fact that official statistics show the value of the mineral production of the United States for the year 1901 to have been $1,092,224,380, and that year by year it is being steadily augmented, it would appear that all matters bearing upon the economy of so important and widespread an industry should have close attention. One of these is mine accounting, and the purpose of this paper is to submit for consideration some fully qualified opinions and comments upon its general principles, more particularly that of cost keeping, which is deemed an essential of modern methods.

Among the many valuable articles THE ENGINEERING MAGAZINE published last year were several in which this vital question of cost-keeping was given prominence. The subjects then dealt with and here referred to related specifically to workshops, factories, and engineering works; yet was there much pertinent criticism and instructive comment equally applicable to other industries. Indeed, a deal of this might have been written in connection with mine accounting, so apposite is it to conditions frequently prevailing where mine cost keeping is concerned.

The value of and necessity for a thorough and effective system of mine accounting does not yet appear to be nearly so generally recognized as the magnitude of the mining industry demands it should be. True, a gradually increasing number of mine owners, whether com-

panies, partnerships, or individuals, either have already adopted or are adopting modern methods and systems which enable mine managers to review continuously the results in course of achievement, and, as a result, to have full confidence that strict economy is being practised and, at the same time, thorough efficiency secured. Yet is there room for a far wider recognition of the fact that the commercial or business part of mining enterprises must be given as close and careful attention as the technical and industrial parts—the mine engineering and the practical mining.

Not only is systematic mine accounting far from being in universal practice, but it is by no means unusual to find directorates of mining companies unwilling to sanction the employment of a sufficient clerical staff to admit of its adoption, notwithstanding that without its assistance the mine manager is seldom able at once to determine where costs are excessive and to apply the remedy. There are, too, many managers of mines who regard the keeping of accounts, particularly cost accounts, in much detail as superfluous and, consequently, as involving expense that is neither necessary nor productive of profit. Frequently this view is prompted and fostered by the existence of an imperative necessity for keeping down expenditure, and to this end the manager, either of his own volition or under instructions from his principals, as far as possible dispenses with office assistance and trusts to his own unrecorded observations and conclusions to guide him in dealing with details of management of the mine under his charge. Seemingly Mr. Chas. U. Carpenter had in mind such men—for they are to be found at mines as well as in workshops and factories—when, in the introductory paper of his excellent series on "Money-Making Management for Workshops and Factories," * he wrote: "In very many cases the superintendent is loaded down with detail work that either he or the management considers he should attend to. This is often carried to such an extreme that he cannot give his attention to the larger and broader problems for which his education, experience, and ability fit him. . . . . At times we can even find a man who has the idea that his own position is strengthened by not having strong assistants, and by keeping all the important details of the work in his own head. Repeating the trite saying of a prominent manufacturer: 'The bane of factory organization is he who keeps all important and necessary information under his hat; whether he be workman, foreman, or superintendent.' The result is that very often when the man and the hat

* THE ENGINEERING MAGAZINE, February—August, 1902.

go out the front door, the desired information goes too, and the efficiency of the organization is seriously impaired until the problems can be taken up and solved by others." Further, Mr. Carpenter attached importance to the necessity for the head of any organization being supported by subordinates with necessary ability to care properly for a large portion of detail work so often forced upon the manager, who is paid a high remuneration because of his supposed knowledge, experience, and ability, and whose chief aim should be to achieve better results, lower costs, and investigate improved methods, machinery, and systems—an impossibility, by the way, where he has to carry the load of detail work sometimes thrust on him.

When the question of what accounts shall be kept at a mine is under consideration a serious difficulty, or what has the appearance of being one, often presents itself, particularly where it is desired to meet for the time being only the simple needs of a mining property as yet in the earlier stages of its development, and at the same time obviate the necessity for a change of system when enlarged mining operations shall call for a corresponding extension of account keeping. At first sight the books in use in an up-to-date office connected with a mine that has already arrived at a more advanced stage—not necessarily become productive, but reached a point where, for reasons of economy, comparisons of cost of work previously done and similar work in progress have become necessary—may seem to be more elaborate and to take more time (with its accompanying cost) than the circumstances of the property would appear to warrant. Again, information and assistance may be sought from published books on the subject, but these are comparatively few. Some of them give a formidable array of forms and examples, useful enough, it may be, to the student with leisure to compare their respective merits, but tending to bewilder the busy mine manager seeking a system that will provide him with well-arranged forms admitting of details of costs being clearly stated and tabulated, so as to be readily accessible at any stage of work as it proceeds.

These difficulties may be admitted, yet there remains the necessity to overcome them. Space limitations prevent going into detail here relative to particular systems, but general principles may be stated. "The first aim of a business man is to establish the principles of economy and act in accordance therewith, and it is commercial considerations which prompt an engineer to shape his practice efficiently." This contention granted, its application to mining follows as a matter of course. The next step is to decide how best to apply it. Professor J. G. Lawn, A. R. S. M., whose book "Mine Accounts and Mining

Book-Keeping" was avowedly written primarily for mining students, and deals at greater length with books and forms that more directly concern the mine manager than with those belonging more peculiarly to the province of a secretary of a mining company, says in his introduction:

> "The importance of a good system of book-keeping to a mine owner can scarcely be over-estimated. This will at once be apparent if we consider briefly some of the reasons for keeping mine accounts. They may be arranged under four heads, viz., those connected with (1) the actual working of a mine; (2) the owner (that is the individual or partnership financially responsible for the working of a mine); (3) the safety of workmen, and (4) the country at large."

Summarized, his reasons, as arranged under these several heads, may be stated as follows: (1) It is necessary to keep accounts in order that the relations of the employer and employed may be correctly regulated; that records of purchase and disposal of stores and materials and of production and sale of ore may be kept, and their influence on the profit or loss of working ascertained; that summaries and analyses of costs can be made so that the manager may be able to ascertain what proportion each bears to total cost, to learn where it is possible to economize, and generally to conduct the working of the mine in an efficient manner. (2) The owner is chiefly interested in finding out, quickly and accurately, whether the result of any period of work has been profit or loss, and why the one or the other has resulted. If profit, whether that is the result of careful and skillful management, or whether the profit ought to have been greater; if loss, whether it is due to poverty or scarcity of mineral or to too heavy expenses in any direction whatsoever, so that he may decide whether the obstacles in the way of profitable mining are insurmountable or not. Further, to understand his position fully, the owner should receive, in addition, periodical reports of the condition of the mine and its prospects. Finally, he should have means of knowing that each man employed duly performs the work allotted to him. (3) As a guarantee that careful and frequent inspections of underground workings and of plant and machinery, to guard against accidents, have been made; that proper records, signed by those responsible, are carefully kept, and that these are accessible to those interested. (4) That mines being not merely of personal and local interest, but as well undertakings of national importance, their working in most countries being regulated by law, it is important that accurate and timely statistics relative to the mining industry be published, to which end a good system of ac-

counts must be employed. Finally, all the foregoing requirements should be fulfilled with the greatest clearness attainable, without undue complexity in the methods and books used and without unnecessary labor and expense. All books should be an effective check, should ensure accuracy and prevent fraud, and should be thoroughly adapted to the particular circumstances and needs of the mine in each case.

Mr. Kenneth Falconer, of Montreal, Quebec, who has given particular attention to the question of cost-keeping, in a forcible article published in THE ENGINEERING MAGAZINE last April, controverting the almost universal idea that clerical and accounting work is non-productive work, makes the following among other well-founded assertions

> "Besides obtaining the correct cost . . . . a proper system of accounting should secure to the management full information as regards all the internal accounts of the business . . . . . and such changes and fluctuations as these accounts may show from time to time. More important still, it should plainly indicate the causes of any such changes whenever they may become unusual or abnormal. This information should always be a matter of current work and not of past history, and should be so promptly secured and recorded in such manner as to facilitate comparison with past records of similar operations or transactions. Thus promptly secured and systematically recorded it will enable most valuable conclusions to be drawn from it and judicious decisions to be based on it. . . . Upon the management rests the responsibility of putting such results to the wisest use as truly as the responsibility of putting to the best use any part of the equipment or of selling to the best advantage the output."

Later in his article Mr. Falconer maintains that:

> "Any office not supplied with modern appliances will be unable to procure and record the results looked for until the value to be obtained from such results is greatly decreased. A monthly statement of all details and results is valuable in direct proportion to the promptness with which it is prepared. Its value lessens greatly with each week or even day that elapses between the month to which it refers and the date it is available for study or use. Comparisons of costs to be of the greatest use should be obtainable as the work progresses, not, as is often the case, so long after its completion that they have partially or completely lost interest and value."

It is unlikely, though, that Mr. Falconer would have it inferred that comparative statements have no permanent value as such. On the other hand, as Mr. Carpenter recommends, the information and results they exhibit should be so presented that their value may be best utilized as a guide to similar operations, or future transactions under similar circumstances, which may sometimes be done by employ-

ing diagrams showing proportions and percentages, these occasionally pointing out leaks more plainly or indicating undue increase in expense more vividly than do figures representing gross amounts.

At intervals during the last two years there have appeared in mining and other journals several comparatively exhaustive articles on mine accounting and connected subjects, written by Mr. Charles V. Jenkins, accountant and purchasing agent of the War Eagle Consolidated Mining & Development Co., Ltd., and of the Centre Star Mining Co., Ltd., both of Rossland, British Columbia. One, entitled "Mine Account Keeping, and the Monthly Statement of Costs, as Adapted to the Business of Metalliferous Mining," presented the main features and principal details of the system of accounts and cost-keeping in use at the War Eagle and Centre Star mines, the practical utility and effectiveness of which system had been demonstrated by several years' convincing experience. The stated object of the writer of that useful and instructive article was "to show in a general way the practical value of a thorough system of book keeping as applied to the management and actual working of a mine; more particularly to demonstrate the utility and importance of a monthly cost sheet; and incidentally to emphasize that a very close attention to the business side of mining is as necessary to successful management as a technical knowledge and practical mining experience." In the course of his article Mr. Jenkins, after pointing out the unsatisfactory and unreliable nature of any such make-shift as a close checking of expenditures covering only short isolated periods, remarked:

> "It too often transpires that the lack or absence of economy is due to not knowing just where it can be taken advantage of. To economize, to be in a position to accomplish any degree of rightly regulated economy, the management must know not only *how* but *where* to apply it. . . . In mining, as conditions are subject to frequent change, while it is essential to know what a piece of work has cost when completed, it is of as much if not more importance to know what it is costing during its progress. A statement of mine costs to be of value must present details of cost before conditions shall have so changed as to render the information practically useless. Now, with the end in view of securing this information when it is most needed, a cost sheet should be a regular monthly statement, segregating and distributing each month's total expenses, and showing the specific charge made to every heading separately under advance in the mine; a statement itemizing and detailing each class and subdivision of labor employed, specifying the nature and amount of all material and supplies consumed, and apportioning all operating expenses and costs of power, and all of the indirect or fixed and general expenses; a statement which will admit of thorough analysis, so as to

exhibit not only the totals of the various items of cost and expense of mining, but to show correctly the cost per foot of advance accomplished, and the exact cost per ton of ore stoped. With such a statement and analysis rendered regularly each calendar month, a manager is in a position to take advantage of opportunities for economy. If the costs for any one month, or for any one heading during any month, appear abnormal or excessive, a comparison of the costs of several preceding periods will readily locate the item of increased cost, and once located, its cause can be ascertained and more than likely removed. In this way only is a manager enabled to effect a saving, or at least to reduce the chance of assured loss by being able to put his hand upon the cause of the loss and to remedy the evil, either by a redistribution of labor, by the utilizing of material to better advantage, or by improving the mechanical appliances or modifying or adapting their use to existing conditions."

What is known as the "Voucher System" is in use at the War Eagle and Centre Star mines, as well as at most of the other mines of the Kootenay and Boundary districts of British Columbia. This requires, in addition to the books ordinarily used in double-entry bookkeeping, the use of a voucher journal, so arranged and ruled as to classify and subdivide the expenditures. The number and form of the various subsidiary books are usually determined by the requirements of each individual mine, experience showing what will best facilitate and simplify the work of account keeping.

Of the system in use at the mines of the Le Roi, Le Roi No. 2, Columbia & Kootenay, and Rossland Great Western mining companies, all at Rossland, Mr. Wm. Thompson, now manager of the mines of the two last-named companies and for several years actively engaged in the management of the Le Roi and Le Roi No. 2, respectively, and who introduced this system into the offices of all these mines, in briefly reviewing the principles on which the accounts are founded and kept, remarks:

"In the first place I would say that successful mine accounting depends entirely upon the correct classification of all labor to be paid for and supplies used. The system we have inaugurated here has been carried out from time to time in the most prominent mines in the United States and Canada, and comprises the following important points: (1) A complete check against the shift bosses and time books, thus preventing any 'padding' of the pay rolls or neglect to give the men the time they worked. (2) A complete check on the work performed by every man in the mine, which being tabulated on the manager's report, at once gives him, in a very condensed form, full information as to the work performed during the previous twenty-four hours, and is absolutely necessary in works of this kind. (3) The forms of reports render available, for the guidance of the accountants, a correct basis on which to apportion the general expenditures between Capital and Revenue accounts. Lastly, I would add

> that the greatest possible care is taken in recording and checking the shift bosses' reports, supplies used, etc., so that a balance is struck every day, and that the reports can be absolutely relied on for accuracy. When the final reports reach the accountants it is very easy matter for them to record the expenditures. It then becomes a question of simple book keeping, using any forms of books available to simplify the work, and having as few entries in the main ledgers as possible."

The reports referred to include those made daily by the shift bosses, which are checked by a separate report from the time keeper; those covering ore production, breaking, and sorting; reports of powder and other supplies used, etc. A weekly mine-labor report and a monthly summary of development labor are also in use. The chief book recording details is designated the Grand Journal, much condensed summaries from which are posted to the ledger in the ordinary way. The monthly statement, showing details and costs of mining operations for the month, is a comprehensive return, with complete information ascertainable at a glance.

Summed up, the chief burden of all the foregoing is cost keeping, and since in all costs the two prime factors are labor and material, experience shows the leading principle of mine accounting to be an accurate and continuous calculation and compilation of expenditures, to secure comprehensive information that will afford a conclusive reply to two main questions: (1) Are all employees giving a full day's work? (2) Is there any waste of stores or other materials? Time and again it has been absolutely demonstrated that large savings and increased efficiency have resulted from the introduction of a rational and complete system of cost-keeping accounting covering all construction, equipment, operating, maintenance, and materials accounts. The ultimate object of this accounting is cost reduction, which can best be secured by mine managers having an intelligent, systematic, and uninterrupted recording of details in daily progress to rely upon for their guidance.

METAL CUTTING WITH THE NEW TOOL STEELS.

By Oberlin Smith.

The extension of the use of the new fast-cutting tool steels is one of the most significant developments in modern machine-shop practice—one of the most fruitful in its possibilities of scarcely foreseen changes. Mr. Smith has been an earnest experimenter in the practical working of the new steels, and in the following pages he outlines some of the certain changes which they will bring in tool design and machining operations.—THE EDITORS.

LOOKING back through history, not perhaps to primeval times, nor even so far back as the days of Tubal Cain, but only through those centuries in which men have practiced the art of cutting the harder metals, such as iron and steel, by means of hardened steel tools, we find that the machine shop has been but a school for the cultivation of a leisurely pessimism.

Reference is here made only to those tools which work upon the shaving or paring principle—not to those which perform shearing and punching, mounted in shearing machines and presses, or of abrading by the use of grinding apparatus. During an unknown number of centuries lathes have been employed for turning metals, at first by the use of hand-held cutting-tools, and later on by tools held and guided in a slide rest or its equivalent. Drilling machines of various kinds were doubtless in use as early as, or perhaps earlier than, turning lathes.

The application of the simplest slide-rest principle developed machines carrying automatically guided tools for almost all forms of metal cutting, including highly specialized apparatus of great power and accuracy. These waited for the commencement of their present great development until early in the nineteenth century. We need not look back more than a hundred years to see the feeble beginnings of the planer, nor half as long for the shaper and milling machine. We need, however, look in retrospect through but a few years to see machine-shop processes carried out on the magnificent scale which have produced so quickly and cheaply all the tremendous machinery plants of the civilized world.

And yet a visitor in one of our splendidly equipped shops, with

every machine running at its full capacity, could, if of a philosophical yet enterprising turn of mind, but be depressed with the inevitable slowness of all the motions going on around him. Who of us has not felt a certain sadness at seeing so many men enjoying a happy idleness, perhaps even for hours at a time, watching the creeping motion of great pieces of metal as they revolve or slide against the tools which slowly bring them to shape by shaving off a few pounds of chips per hour? Who among us has not pictured some ideal future process whereby metallic articles could lose their skins, so to speak, with somewhat more of the hustle and vim incident to wood-working and even to shoe-making establishments, where everybody seems to be going ahead, instead of sitting still? Who has not been subdued and made pessimistic by the apparent utter impossibility of improving the metal-cutting business, with its speeds of from 10 to 30 feet per minute, often averaging less than 20, even in a well managed shop? Who has not felt that machine work was bound by the laws of the Creator to be performed slowly, and that the machinery produced thereby was necessarily to remain phenomenally expensive? And who has not drawn comparisons, and noted the strong contrast between the production of this class of work and that practiced in saw mills, or cotton factories?

A new era, however, is not only dawning, but seems to have almost burst upon us in full effulgence. Its beginnings are almost coincident with the birth of this marvelous and to-be-mighty twentieth century. Where a few years ago wrought iron and the milder forms of steel (those all-important components of machinery) could be cut at an average rate of about 20 feet per minute, we may now regard from 50 to 100 feet per minute as a conservative estimate for the actual practice attainable by any machine shop, from this time on—that is, under conditions where the work or the tools, as the case may be, can be run at such speeds with a smooth and uniform motion, as is the case with ordinary, straight, lathe work, such as shafts, axles, etc.

As is well-known, the cruel limitation in speed of former historical times (that is of a year or two ago), which seemed to all of us an insurmountable one, was due to the frictional heating of the tool, and its consequent softening by the drawing of its temper. Some improvement in this respect was made when the so-called self-hardening steels were introduced, several years since; but practically no very considerable increase of speed was obtained, as with much faster running these tools seemed to break or be rapidly abraded out of shape. With certain tools of the milling-cutter type, considerably higher

speeds were attained by having a great many cutting edges to do the work, so that a great majority of them could be out of service and cooling, while a few were actually cutting. By this means, and by the liberal use of a cooling lubricant, practical milling speeds upon wrought iron were obtained as high as about 80 feet per minute, but these were not found possible in ordinary turning or planing, even with thorough lubrication. The highest recorded speed known to me that has been attained under the old *régime,* with the very best quality of tool steel, was in the drilling of certain gun barrels, where a powerful stream of cold oil was forced through the drill under a heavy pressure, so as constantly to cool its cutting edges and keep them comparatively clear of chip friction by carrying the chips outward in its rapid torrent, alongside the shank of the drill. Under these extremely favorable circumstances speeds as high as 100 feet per minute have been reached, but nothing approaching this was possible in ordinary work.

In considering this question some of us have dreamed dreams and have pondered upon complicated schemes for doing cutting work in tanks of freezing mixtures, or for changing temporarily (perhaps in some chemical or electrical way) the molecular construction of the metal to be worked. All these have been swept away, or laid aside for the time being, by the men who have actually accomplished what the world has so long sought for, and that by the simplest means, the only change being in the material and the heat treatment of the cutting edge of the tool. May all honor and much profit come to these faithful pioneers!

This seemingly trivial, but mighty invention, is about as young as the century, the tools in question having been used in actual practice, upon a commercial scale, but for a very little time past. Meanwhile, a further development has taken place, not only in the high-speed quality and the strength of the various steels experimented with, but more especially in simplicity of treatment during the hardening process.

Many machinery manufacturers appear to have been waiting for a cheapening of the very considerable expenditure which at first it seemed necessary to incur—both for the new tool steel itself and for the special apparatus for hardening, and otherwise treating it. They felt that a time might soon come when no special plant would be required for its use and when, as with all new inventions, various improvements would reduce the cost of the article invented to a basis comparable with that of its older rivals.

The wished-for time in question seems to have come even sooner than could have been hoped for. Suddenly, almost, there have

appeared in the open market various brands of high-speed steel, manufactured both in Europe and in America, which, to a greater or less degree, accomplish most marvelous work, and work which would have seemed almost impossible a few years ago. Not only will these new tools cut two-fold or three-fold faster than the best tool steel of the recent past, but their durability is in some cases amazing, as when a lathe tool will run several hours in cutting forged steel with no sharpening except perhaps the slight filing off (without removing from the tool post) of a burr which builds itself up upon the top surface of the cutting edge from fine particles of the steel being cut, which seem to weld themselves fast. This burr does not break off until after the tool has been used long enough for the chips to dig a decided hole in its upper face, thus leaving the cutting edge much more acute than it was at first and giving the burr less chance to hold on. After a tool has been concaved this way too much, a little ordinary grinding of the top face will restore it to good working order.

In some cases the chips will be heated to a dull red with the tool nearly as hot. When working efficiently it is never expected that the chips will come off as bright metal, the heat naturally discoloring them to a deep blue, or beyond the blue stage to a grayish black. Water upon the tool is of some advantage, but, fortunately, the new steel does excellent work when perfectly dry, thus avoiding the inconvenience of wet cutting.

Furthermore, some of this steel seems to delight in being abused, maltreated, and persecuted to the utmost degree. One kind recently tested by me apparently suffered not at all by having its cutting edge burnt to the melting point, the whole treatment of hardening being extremely simple, in an ordinary forge fire—and this without the danger of "temper cracks" incident to the old-fashioned steels.

With this particular grade of steel, a speed of over 200 feet per minute was attained in turning a 4-inch forged-steel shaft of about 0.50 per cent. carbon, but the cutting edge gave out after running along several inches. Shafts of the same kind were readily turned, however, at 160 feet per minute, as the steel was originally received from the makers. On one occasion a tool ran for seven hours at nearly this speed, but the work might have been a little softer than above mentioned. Speeds of from 80 to 120 feet per minute have since been attained as a regular every-day occurrence, upon medium hard steel, but no exhaustive experiments have been made to determine suitable speeds for wrought iron and mild steel. With cast iron it has been found practicable to use these same tools at speeds of from 40 to 50

feet per minute only. Other experimenters, however, have attained speeds of more than 100 feet upon cast iron, with tools especially tempered for cutting this material.

A statement has recently been made public regarding a new German tool steel which will cut forged steel at 150 feet a minute and cast iron at 120 feet. Much durability is also spoken of, the tools running without grinding for many hours, and sometimes for many days. It is certainly to be hoped that this is all true, for actual work, but tool users feel that the whole subject is still somewhat in an experimental stage. From the evidence thus far obtained there seems to be no question that 100 feet a minute for many of the ordinary machine-shop operations will be a future standard, instead of the 20 or 25 feet which so many people have heretofore contented themselves with.

Besides this wonderful increase in speed, we fortunately have greater strength and far greater durability in the cutting edges of these tools, so that less time is wasted in removing, grinding, and replacing them in the machine. They have, moreover, a capacity for deeper and wider cuts than usual, with a consequent greater weight of metal removed per foot of travel. When this increase is multiplied by the higher speed, together with, as above mentioned, longer continuous running without grinding, it must be apparent to all that we have suddenly arrived at a new and perhaps startling era in the art of metal working. What this means to the industrial world, from the point of view of the political economist and social scientist, to say nothing of statesmen and politicians, we probably none of us realize at this time. The changes that are destined to occur in the cheapening of machinery making, with the consequent impetus that will be given to its production, are for the future to determine. That they will have a marked influence upon the whole civilization of the world, as the improved methods gradually become standardized, there can be no question.

Looking again at this subject from a merely mechanical standpoint, we must not only deal with the question of increased speed in the spindles and countershafts of our lathes and other rotary tools, attained probably in most cases by speeding up the line shafting also; but, to get the full effect of the impending reform, we must have the machine-tools themselves built much stronger and heavier. This will be needed, not only to allow for the additional vibration due to the higher speed, but also for the heavier chips that we expect to remove. This obviously means that the present designs of machine tools will gradually become obsolete, and that new ones will be designed which are vastly

more massive and rigid than the majority of the types in present-day machine shops.

When several years ago I earnestly advocated in the columns of the *American Machinist* the use of a much heavier framework for machine tools, together with large spindles and long bearings, contrasting this desired "anvil principle" with the "fiddle principle" so universally present at that time, I of course could not foresee the coming high-speed, heavy-chip era, which probably may force the anvil principle, in an intensified degree, upon many heretofore reluctant designers and users. This means that the frame or bed and other stationary parts of a machine cannot be too heavy, so there is room for a man to walk around it. The slowly moving parts should also be as clumsy as is consistent with convenient handling. The cost of extra cast iron should be considered not at all. We must buy all the inertia and rigidity we can get—at any price.

In altering and reequipping machine shops for the new methods it must be remembered that these high speeds and heavy cuts will take much more power than formerly, and this will mean the improvement and increase of generating and transmitting machinery.

In doing this it is to be hoped that one of the incidental changes will be in the line of abolishing shafting and belting as much as possible, and in the use of individual electric motors especially adapted to each machine—in some cases forming a component part thereof. Heretofore the high cost of motors, and the difficulty of obtaining many variations of speed under greatly varying loads, has retarded the development of such electrical driving. Recent improvements in design and in methods of manufacture have, however, removed some of these difficulties. Still other improvements, especially in the matter of motor control, are no doubt destined in the near future to bring the electrical machine shop* boldly to the front.

It will be noticed that reference has more than once been made to the speeding up of rotary machines. Obviously, drilling, boring, and milling machines may have their speeds increased to almost any extent, as the rotary parts are of moderate size and usually symmetrical. Thus high speeds will not prevent quick starting and will not throw them out of balance. The same thing applies to lathes, when the work is circular, as in case of wheels, straight shafts, etc. In the case of irregular lathe work, like crank shafts, and other non-symmetrical objects, there may be considerable limitation in regard to rotary speed.

* See Mr. Kimball's article elsewhere in this issue. In May and June the papers in Mr. Kimball's series will be devoted especially to the electric motor in the machine shop.

although much can sometimes be done by proper attention to artificial balancing.

In considering reciprocating machines we have an entirely different problem, although in cases where the tool, rather than the work, moves, as in shapers and slotters, no great difficulty need be expected in arranging for the new speeds, as the parts affected by inertia, when changing their velocity, are usually not very heavy. In the case of planers, however, where the work itself, together with the large table of the machine, reciprocates against the stationary tool, we obviously cannot expect much greater speed than at present, especially in the case of large machines carrying very heavy work. The inertia of such weighty reciprocating objects, which must stop and start several times a minute, will certainly prevent the high cutting speeds desired.

A friend suggests that at the other side of the scale stands the very large class of operations in which the limits are set, not by the strength and capacity of the tools or the machines, but of the work itself, it being of small advantage to save time in turning a light shaft, for example, and produce but a snake. This criticism well applies to one point referred to—the taking off of bigger chips—but it is not pertinent to the greater advantage obtained by a high speed. A light shaft can be run fast as well as slow, providing it is symmetrical and is properly guided by "follow rests," etc.

An exception to this statement may sometimes be necessary in the case of very small shafts in which there is so little body of metal that the shaft gets almost as hot as the chips—so much so as to warp out of shape. In recent experiments, however, a 1-inch shaft was reduced at several cuts to ½-inch and remained white, with the chips coming off at a deep blue color.

In view of the foregoing it would seem that for larger work at all events, an incidental effect of the little chemical changes which have been worked out in the crucible, upon some pieces of iron mixed with certain carbon and other stuff, will not only serve to change various economic aspects of the world by billions of dollars, but, mechanically speaking, will tend to substitute milling machines for planers, and will so change the design of the planers themselves as to make them move the tool rather than the work.

Just how all the things here hinted at will work out in practice within the next decade or so it is difficult to foretell; but whether or not some very radical alterations will, by reason of the various causes now appearing, be effected in our machine shops would seem to me, at

least, to be a question with but one answer—and that, of course, the unhesitating affirmative.

It should not be inferred from the foregoing facts and deductions that the mechanical world is to be immediately reformed, after the manner of a tidal wave, so to speak. A natural feeling of conservatism and a disinclination to spend more money than seems absolutely necessary will, for some time to come, deter many shops from making radical changes, especially in the way of a re-equipment with heavier tools. It must also be remembered that the large aggregate saving in the cost of production, which will be the eventual result of the new methods, will not be so immediately apparent, by reason of the fact that the gains will be, for the first few years, largely offset by an enormous cost account in making the change. Much economy will doubtless result, in perhaps a majority of our present machine shops, merely by the substitution of cutting tools made of the new high-speed steels, to be used in connection with the present machine tools, these latter being speeded up by comparatively inexpensive changes in pulleys, belts, etc. In this case, however, it will often be necessary to increase the steam plant or other source of power, because on such machines as are run at a high speed the necessary horse power for driving will be increased in about the same ratio as the velocity. This, however, cannot, as before remarked, apply to all the machines in the shop, but only to those which are not handicapped by reciprocating motions, or by the rotation of irregular work.

Meanwhile, the substitution of different types of planers, together with heavier and stronger machines in general, will go on gradually. The great expense incident to this change, by reason of making many of the old tools obsolete, and because the new ones will each be heavier and more expensive, will be incurred gradually, especially in the older shops. The grand change in machine-shop methods hinted at in this essay will not, therefore, occur as a cataclysm, but will come upon us gradually, though perhaps with an increasing velocity ratio, during the years of a coming decade or two—thus giving us ample time to become thoroughly accustomed to the change.

COST-FINDING METHODS FOR MODERATE-SIZED SHOPS.

THE SHOP SYSTEM OF THE CANADIAN COMPOSING COMPANY.

By Kenneth Falconer.

The series of articles of which this is the fifth began in December last with an account of a system in use in a well-managed boiler shop. In January the example taken was a machine-tool works using the premium plan, and in February, a printing-press factory in which stock tracing was a peculiarly important feature. Last month the description was of an efficient but simplified and standardized system employed in an engine and boiler works. The following paper concludes this group. The purpose of every one has been to furnish a working description of a practical system, in actual use in a shop where it has stood the test of time and proved sufficient, and with this to give fac-simile reproductions of all forms and blanks. This makes the articles particularly useful to those concerned with shop accounting.—THE EDITORS.

THE Canadian Composing Company, Ltd., of Montreal, manufacturing the Monoline composing machine, employ some 125 to 150 hands, about 30 of whom are girls. The nature of their product demanding perfect workmanship and interchangeability of parts, the greater number of their employees are highly skilled mechanics; the fact that they manufacture one machine only, together with the fact that practically all the parts entering into its construction are of such size as to be easily handled by one man, greatly simplifies the question of handling material and work in process of manufacture. The stores department are thus enabled to take the responsibility of preparing and issuing the material required for a productive order, as a consequence leaving the foremen free to devote all their attention to the actual productive work of the company. For the sake of distinction, that part of the stores responsible for this work is known as the "stores-distributing room."

Under the immediate control of the superintendent and his assistant are the stores-distributing room, the stock both of rough material and of finished parts, the tool room, the rate-fixing and inspection department, and the cost department. Productive orders for the manufacture of a machine or lot of machines go to the assistant superintendent, and are entered in an order book in the stores-distributing room. This book is under the control of the store keeper, who is also the distributing clerk, and on him is the responsibility of having on hand enough finished parts to supply for such orders, and the necessary material to keep up to a safe limit his stock of finished parts.

PIECE_____ WEIGHT_____

RECEIVED				SENT OUT		
Date	Order No.	No. Pieces	Weight	Date	No. Pieces	REMARKS

FIG. I. STOCK LEDGER FOR FINISHED CASTINGS.
Original is 7¾ inches wide, ruled in red and blue on white paper.

SIZE_____

RECEIVED				SENT OUT			
Date	Order No.	Feet	Weight	Date	For Part	Feet	Weight

FIG. IA. STOCK LEDGER FOR RAW MATERIAL.
Same size, etc., as Fig. 1. The cuts give the heading and method of ruling only. The originals of course are much longer.

CANADIAN COMPOSING CO., Ltd.

High _____ ○

Low _____ Part No. _____

Date.	Rec'd.	Date.	Used.	Bal.

FIG. 2. STOCK CARD. HEADING AND RULING.
The original is 3½ inches wide by 7 inches high, manila card.

LIST OF MATERIAL TO BE SAWED FOR 15 MACHINES.

Machine 27.

KEYBOARD.

B.	NAME OF PART	MATERIAL	THICK	WIDTH	LENGTH	NO. OF PIECES
300	Top of front comb	Tool steel	3/16	5/8	11 11/16	15
451-452	Right and left bearings	Cold rolled	3/8	3/8	4 5/8	30
11010	Front bar	Cold rolled	1/4	7/8	11 3/8	15
11702	Spring comb	Brass	3/16	1 1/4	11 9/16	15
C.		MAGAZINE.				
3	Back plate	Mach. steel	3/8	3 1/2	10 9/16	15
50	Partition plate separator	Cold rolled	3/16	3/8	7 3/16	15
281-5	Thicking piece for front end of Accelerator lever	Tool steel	3/32	5/8	3	25
286-8	do.	Tool steel	1/8	5/8	3	25
309	Lock slide do.	Mach. steel	1/4	3/4	7 1/2	15
311	Angle piece	Cold rolled	1/4	5/8	8	1
327	Toggle	Tool steel	1	5/8	8 3/4	1
346	Lock on latch	Tool steel	5/16	5/16	3 3/4	3
349	Thickening piece to connect latch	Tool steel	1/2	3/4	5	3
357	Auxiliary ejector	Tool steel	1/16	1/2	2 15/16	15
358	Ejector	Tool steel	1/2	1/2	3 1/8	15
364	Bearing for retaining pawl	Mach. steel	3/8	5/8	6	2
365	Block on top of space box	Mach. steel	5/8	7/8	6 3/8	4

FIG. 3. LIST OF MATERIAL REQUIRED FOR 15 KEYBOARDS AND MAGAZINES.

Figures 1 and 1A show the ruling of two of the stock ledgers, of which a complete set are kept, covering all lines of raw material and finished parts.

Figure 2 is a stock card, kept on the shelves or bins with the goods to which it has reference. All receipts and withdrawals are noted on this card, so that should the quantity on hand drop below the limit, the fact is at once brought to attention and an order issued to manufacture a further supply—usually the quantity required for fifteen machines.

The parts of which a Monoline composing machine is composed are each known by a number, each group of numbers being indicated by a prefix. Thus the letter B may represent the key-board, the various parts of which it is composed being known as B1, B2, etc.

Figure 3 is a section of a list kept in the stores department

PIECE_____ WEIGHT_____

RECEIVED				SENT OUT		
Date	Order No.	No. Pieces	Weight	Date	No. Pieces	REMARKS

FIG. 1. STOCK LEDGER FOR FINISHED CASTINGS.
Original is 7¾ inches wide, ruled in red and blue on white paper.

SIZE_____

RECEIVED				SENT OUT			
Date	Order No.	Feet	Weight	Date	For Part	Feet	Weight

FIG. 1A. STOCK LEDGER FOR RAW MATERIAL.
Same size, etc., as Fig. 1. The cuts give the heading and method of ruling only. The originals of course are much longer.

CANADIAN COMPOSING CO., Ltd.

High _____ ○

Low _____ Part No. _____

Date.		Rec'd.	Date.		Used.	Bal.

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The original is 3½ inches wide by 7 inches high, manila card.

LIST OF MATERIAL TO BE SAWED FOR 15 MACHINES.

Machine 27.

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11010	Front bar	Cold rolled	1/4	7/8	11 3/8	15
11702	Spring comb	Brass	3/16	1 1/4	11 9/16	15
C.		MAGAZINE.				
3	Back plate	Mach. steel	3/8	3 1/2	10 9/16	15
50	Partition plate separator	Cold rolled	3/16	3/8	7 3/16	15
281-5	Thicking piece for front end of Accelerator lever	Tool steel	3/32	5/8	3	25
286-8	do.	Tool steel	1/8	5/8	3	25
309	Lock slide do. do.	Mach steel	1/4	3/4	7 1/2	15
311	Angle piece	Cold rolled	1/4	5/8	8	1
327	Toggle	Tool steel	1	1 5/8	8 3/4	3
346	Lock on latch	Tool steel	5/16	5/16	3 3/4	3
349	Thickening piece to connect latch	Tool steel	1/2	3/4	5	4
357	Auxiliary ejector	Tool steel	1/8	1/2	2 15/16	15
358	Ejector	Tool steel	1/2	1/2	3 1/8	15
364	Bearing for retaining pawl	Mach. steel	3/8	5/8	6	2
365	Block on top of space box	Mach. steel	5/8	7/8	6 3/8	4

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Figures 1 and 1A show the ruling of two of the stock ledgers, of which a complete set are kept, covering all lines of raw material and finished parts.

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The parts of which a Monoline composing machine is composed are each known by a number, each group of numbers being indicated by a prefix. Thus the letter B may represent the key-board, the various parts of which it is composed being known as B1, B2, etc.

Figure 3 is a section of a list kept in the stores department

showing the exact quantity, dimensions, and kind of material required to make a given number of each part. When an order (Figure 4) is issued for the manufacture of any part it is entered in the order book, and the rough material drawn from stores and cut to dimensions as

Order_____

The Canadian Composing Co. Limited.

Montreal. Feb. 3 1903

To Mr. F. Lefebore

MATERIAL REQUIRED.

X A.M. P.M. Feb. 12th 1903

2 Sets of Matrices #8.4

4 Sets of Space-bands

Accepted W. W. Wotherspoon

F. Lefebore Supt. Dept.

Foreman of Metric Dept.

Remarks_____

THIS REQUISITION REQUIRES A DEFINITE ANSWER.

FIG. 4. ORDER FOR PARTS.

Original is 4¼ inches wide by 5 inches high, thin white paper, joined to duplicate by perforated margin on the left. Signed and date promised (at point marked X) by foreman.

called for on this list. Figure 5 is a page from the Book of Operations, copies of which are in all the shops as well as in the stores-distributing room. This book shows in proper sequence the different operations each part undergoes during manufacture, the machine on which each operation is done (which usually bears the same number as the man operating it), and the tools required therefor.

When the material is ready it is placed in a box and sent to the

stores-distributing room; an order ticket (Figure 6) is then made out and placed in a holder on the end of the box, and the necessary tools as called for by the book of operations are taken from the tool shelves and put in a box the same size as that containing the material, but painted a different color. The lot number and part number on this order ticket practically form the order number to which the material is charged, and to which the workman later on charges up his time. These and the operation number are filled in, leaving the workman's name and time of starting to be noted when the material is taken to the shops. Around the two sides of the stores-distributing room runs what is generally spoken of as "the rail." This is an ordinary railing or balustrade enclosing the tool racks and stores-distributing room, and leaving a passageway leading to

Op. 1—Wind in piece 6 in. long.
Machine—15.
Op. 2—Cutting off.
Man—35.
Op. 3—Finishing ends.
Man—35.

C 364—BEARING FOR RETAINING PAWL.

Mat.—Machinery steel. Two pieces 6 in. long.
List No. 4..... .... Drawing No. 139
Mat.—Machinery steel.
Size—3-8 in. thick, 5-8 in. wide, 6 in. long.
Op. 1—Milling front.
Machine—5.
Op. 2—Milling right-hand side.
Machine—5.
Op. 3—Milling left-hand side.
Machine—5.
Op. 4—Milling back.
Machine—5.
Op. 5—Sawing off.
Machine—5.
Op. 5a—Butt milling ends.
Machine—5.
Op. 6—Drilling.
Have jig.
Drill No. 44.
" " 28.
Machine—33.
Op. 7—Slotting.
Have cutter.
Machine—5.
Op. 8—Slotting angle with a parallel to straddle vise.
Use same cutter as Op. 7.
Have parallel.
Machine—5.
Op. 9—Countersinking.
Machine—33.
Op. 10—Reaming.
Same reamer as C 348, Op. 8.
Machine—33.

C 364a—RIVET.
List No. 8 ... ...Drawing No.....
Mat.—Soft wire.
Op. 1—Cutting off.
Use wire cutter.
Boy.

C 365—BLOCK ON TOP OF SPACE BOX.

List No. 4..... ....Drawing No.....
Mat.—Machinery steel.
Size 5-8 in. thick, 7-8 in. wide, 6$\frac{3}{4}$ in. long.
Op. 1—Mill back.
Machine—5.
Op. 2—Mill right hand side.
Machine—5.
Op. 3—Mill left hand side.
Machine—5.

FIG. 5. BOOK OF OPERATIONS.

THE CANADIAN COMPOSING COMPANY, Limited.

ORDER TICKET.

Mr. Thompson J. No. 30 Lot 7

	COMMENCED. TIME	FINISHED. TIME
Part No. C 5		
Operation No. 8 JAN 8	4 31/32 PM 1903	
No. of Parts 86	Foreman's O. K. Starting Signed A. J. Daly	Foreman's O. K. Finished. Signed

FIG. 6. ORDER TICKET.

Original is 5¾ by 2⅝ inches, yellow card. Date is filled in by time-clock stamp.

the entrance of the shops; on it, at regular distances, are painted numbers corresponding to those of the men or machines. The company assert: "This takes space but pays."

The shops are worked on the gang system, a sub-foreman being in charge of a small number of men and responsible for keeping them continuously supplied with work. Each morning at a certain hour these sub-foremen visit the stores-distributing room and notify the assistant superintendent what men or machines are likely to be out of a job during that day. Together they consult the order books, and having decided to which order to give precedence, the boxes containing the necessary material and tools for it are placed beside the rail opposite the number of the machine on which the next operation will be done, the workman's number being entered on the order ticket and noted in the order book. For expense or repair orders the order ticket used is practically the same as that shown, but of a different color, and has a page number substituted for the lot and part number. This page number represents the page of the expense cost book to which all charges against such work are posted.

On coming to work each morning the workmen pass through the stores-distributing room, and each receives a time card (Figure 7) on which the date and time is marked. The clock for this purpose is kept beside the door leading from the stores-distributing room to the shops. On reaching his bench the workman fills in all other particulars called for on his time card from the ticket representing the order on which he was engaged the previous day, and as a rule he continues on the same job until completion of the operation or operations specified on the order ticket. In exceptional cases an order may be suspended and a rush order given him in its place; in such case the ticket

for the suspended order is kept in the stores department until such time as it is determined to put it in hand again.

On completion of the work called for on the order ticket, the workman takes the two boxes, one containing it and the other the tools he has used, to the inspection department. He knows that beside the rail, opposite the number of his machine, he will find the material and tools for the next work he is to take in hand. After delivering the boxes at "inspection," he stamps the time card he has been using, turns it into the stores-distributing room, and receives another with the hour and date marked on it; all other particulars he fills in from the order ticket which accompanies the material and tools handed to him by the stores department from beside the rail opposite his number. All loss of time "between jobs" is thus eliminated. Before any workman has completed any given operation the material and tools for the next job are ready for him, with full instructions as to the operation which he is next to undertake. On receipt of material and tools by "inspection," both are carefully examined and the former either sent back to the stores-distributing room for the next operation, or to stock if completed. In the former case an order ticket bearing the same number, but indicating the next operation, is made out and it is then treated exactly as if it were a new order. The tools are never returned to the tool shelves unless in perfect order. If they require repairs, a check showing the disposition of them is placed on the tool racks; otherwise they themselves are sent back to the stores and returned to their proper location.

Orders for assembling a machine or a lot of machines largely follow the same routine. The parts required are supplied in proper

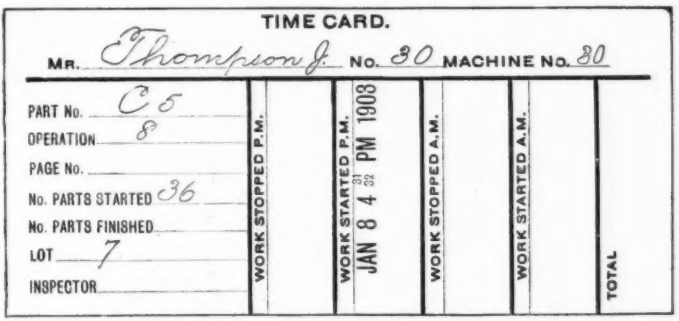

FIG. 7. TIME CARD.

Original is 5¾ by 2⅝ inches, blue card. Time is filled in by time-clock stamp.

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THE CANADIAN COMPO

No. of Part.	Operation.	NAME OF EMPLOYEE.	Employees No.	Machine No.	INSPECTION. DAILY TIME AND NUMBER ACCEPTED. SATURDAY. Hours.	Pieces.	MONDAY. Hours.	Pieces.	TUESDAY. Hours.	Pieces.	WEDNESDAY. Hours.	Pieces.	THURSDAY. Hours.	Pieces.	FRIDAY. Hours.	Pieces.

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SING COMPANY, LIMITED.

Page No.

STARTED. No. of Pieces.	Mo.	Day.	COMPLETED. No. of Pieces.	Mo.	Day.	Time to complete work. Hours.		PAYMENT. Day Rate. Payment per Hour.	Differential Piece Rate. To Receive Highest Price Work must be done at Rate of: Pieces in	Hour	High Rate	Low Rate	COST. Labor.		Material.		Totol.		Cost of One Piece.		REMARKS

FIG. 9. COST BOOK. THE REPRODUCTION SHOWS THE HEADINGS AND METHOD OF RULING.

On account of its width, the page is shown in two sections. The lower cut should be placed to the right of the upper one.
The original is 17 inches wide.

THE CANADIAN COMPOSING COMPANY, LIMITED.

PAY ROLL FOR — APPROVED FOR PAYMENT. — CORRECT. — EXAMINED AND REGISTERED.

Week ending _____ 190

EMPLOYEE'S NAME	No.	DAY WORK TIME: Sat.	Mon.	Tues.	Wed.	Thur.	Fri.	Total Time	Rate	Piece Work Wages	Total P.W. Wages	Day Work Wages	Total Wages Due	Deductions	Net Wages Due
Page Hours										Page Amount					
Page Hours										Page Amount					

FIG. 10. WEEKLY PAY ROLL, SHOWING HEADING AND METHOD OF RULING. ORIGINAL IS 13 INCHES WIDE.

rotation from the distributing room, the necessary tools, however, being kept in the assembling room under charge of the foreman of that department.

Figure 8 (page 98) is the back of such order tickets as are issued for operations paid for by piece work. It will be seen that the system in use is the Taylor differential piece-rate system, which has been fully described in the Works Management Number of THE ENGINEERING MAGAZINE. The management find that their gain in increased output fully justifies them in paying the high rate if the work is done within the limit set.

Figure 9 shows the ruling and heading of the cost books. The workman's time ticket and the reports from inspection are entered up in these books each day, and it will be seen that the management are thus always in close touch with all work in progress, its condition, and its location. The cost book shows only the labor and material cost, the proportion of shop expenses being added in the office.

Before leaving the works each man turns in his time card for the job on which he was engaged at quitting time, but leaves the order ticket for such job at his bench with the

CONTRACT.

DAY RATE	DIFFERENTIAL PIECE RATE.				
Per Hour	To Receive the Highest Price, Work Must be Done at the Rate of				
	PIECES IN	HOURS.	HIGH RATE.	Low Rate	Lowest
20c	1	2	70¢	44	28
	86	72	$25.20	15.84	10.08

The person accepting this contract for piece work agrees to complete the work specified on back to the satisfaction of the inspector, and for the amount named in the contract. Only such work as passes inspection will be paid for, and the workman will be charged for lost labor on parts spoiled while he holds this contract, unless occurring from a cause for which he was not responsible.

Mr. _____ No. _____

FIG. 8. BACK OF ORDER TICKET FOR PIECE-WORK JOBS.
Original is 6 inches wide by 2⅝ inches high, green card.

unfinished work. The time, as shown by the cards each day, is credited to him; no other record of his entrance or departure is kept.

Figure 10 is part of the weekly pay roll, which is made up from the workmen's time cards. For convenience, fractions of hours are figured in decimals, and the time clock was especially made so to record the time. In case of any error or dispute with a workman, the pay roll can be at once verified by reference to his time cards. As these have been made out and signed by himself, it will be seen that he is to all intents and purposes his own time keeper.

As has been stated, the Canadian Composing Company work under circumstances exceptionally favorable to securing both continuity of manufacture and maximum of output. Where a greater variety of product is manufactured this system would not be applicable in its entirety, but there are points of merit in it which might be applied with advantage to some department or shop of very many productive organizations.

EDITORIAL COMMENT

THE archaic state of the labor problem—which it is Mr. Carpenter's earnest purpose in his leading article in this issue to point out and to amend—is one of the most anomalous and inexcusable features of the times. At every other point in the whole industrial system, fore-sighted and far-sighted economy is in supreme control, shaping the design and directing the working of every part. Loads and strains are calculated and provided for; friction and wear are forestalled; wastes are foreseen and remedied or utilized; emergencies and interruptions are prevented, or their possibility and power for harm are minimized; forces are gauged with nicety to the work to be done; costs are figured to the uttermost of exactness. It is our boast that productivity is being constantly and rapidly increased, and that the productive industries are being brought more and more under the control of the engineer, whose characteristic function was recently defined in these pages as being "to know and to foresee exactly what are the conditions affecting every step he takes."

But turn to the field of labor, and all this science gives way to rule of thumb—or to no rule at all, but the little-better-than-brutal plan of "muddling through." Here and there a manufacturer studies the nature and needs of the vital factor in production—the workman; here and there is put forth a policy based on careful study of the real economy of human effort; here and there a system is advanced aiming at development of the best efficiency of the man. But even when these things are tried, it is often so half-heartedly or so less-than-half understandingly that the possible good is lost. Manufacturers who would not think of installing new motive power, or changing a transmission system or a tool drive without careful education of those affected, assume that a novel and complex wage system can be suddenly introduced by mere act of will.

But it is all too rarely that anything in the way of advance is attempted. Too generally, even yet, the idea prevails that the sole rule to follow in dealing with wage workers is to pay as little as possible for a "day's time," and that further relations can be left to the charge of almost any one, as a side issue to general duties of management or sub-management. Nobody would think that about a dynamo, and yet a dynamo is a far less complicated machine than a workingman.

It ought not to be thought unnatural that labor, finding itself invested by unionism with a power as arbitrary as that heretofore exercised by some employers, should fall into the same evil fallacy and think that "You shall" and "I will" are the ultimate law, providing only there is strong enough physical force behind them. It is no wonder that unionism has made itself odious by tyranny and unreason, especially, as Mr. Carpenter suggests, since the attitude of employers has held back the more conservative workmen and turned over the labor councils to the radical and violent. And so the commonest—one might almost say the usual—relation of organized labor to organized management has been in

some "test of strength"—generally a "test to destruction," in the desires at least of the parties involved. Think of applying the same fatuous methods to the mechanical power plant!

What both sides must learn, as the anthracite strike in the United States has made clearer perhaps than ever before, is that there are higher laws of "anthropo-dynamics," just as there are of thermo-dynamics—higher principles of conciliation, as there are of lubrication—which must be recognized before any true economy can be reached in productive effort. Any conditions forced against the dictates of these laws involve inevitable friction, waste, and destruction.

In short, the dictation of conditions by either employer or employed, without due regard to the essential interests of the other side, is false practice. And the attempt to maintain it by appeal to force is intolerable to the new conceptions of the inherent virtue of economy and the innate sin of waste.

And the fundamental need for the furtherance of this ideal is—Conference. "*The time to stop trouble is before it begins.*" Conference, in a spirit of common justice and common sense, would do wonders in changing the reciprocal feelings and attitude of employers and employed. And unionism, deplorable and hideous as are many of its present manifestations, is the most promising agency for the efficient development and application of the power of conference.

* * *

THERE has rarely been a more striking example of the power of the truth than is afforded by the final adoption of the Panama route for the Isthmian Canal. It has prevailed by an almost unanimous vote of the Senate, although a very few years ago it was about as friendless a proposition as ever ventured to ask for a fair hearing. And for the entire intervening period of investigation and discussion, it has been the target for the most unmeasured and the most insidious attack which the lobbies or the floors at Washington, and the columns of an insistent section of the press, could devise and direct.

It has had to fight its way against widespread misconception and reckless misstatement—partly ignorant and partly malicious—as to the physical and financial conditions to be met; against false sentiment and misdirected patriotism which had been taught to think the route "less American" than some other; against mysterious pressure exerted to suppress every evidence of its superior advantages and to gild the very indefinite prospectus of opposing schemes; against the over-reaching greed of French owners and the obstinate folly of Colombian "statesmen"; against the sinister tactics of transportation companies which considered (in utter mistake, we firmly believe) that the opening of an Isthmian Canal would be adverse to their interests; against, finally, the bitter personal enmity of the senator who had always posed as the "father of the Isthmian Canal" and thereby long held an influence which once appeared almost strong enough to lead the country into deplorable error. On his ultimate sacrifice of most of that influence and much of the respect and confidence in which he had been held it is needless to dwell. The names which will be linked in honor with the great enterprise are those of George B. Morison, who so ably demonstrated its physical advantages—of John C. Spooner, who carried to successful passage the act enabling the acquisition of the rights and property—and of John Hay, whose patient efforts negotiated the treaty giving the United States all needful territorial control.

REVIEW OF THE ENGINEERING PRESS.
"THE WORLD IS ITS FIELD"

INTERURBAN ELECTRIC TRACTION.

THE DEVELOPMENT OF LOCAL TRAFFIC AND THE ABSORPTION OF PASSENGER AND MERCHANDISE BUSINESS OF STEAM RAILWAYS.

Practical Experience in Ohio.

THE question of the electrification of main-line railways, to use the awkward term which seems to have come into general use, has been discussed from various standpoints, the locomotive engineer having demonstrated to his own satisfaction that the amount of money locked up in steam machinery is a bar to the change, while the electrical engineer maintains that the steam locomotive is an early and universal candidate for the scrap heap. In the meantime the problem has been working out its own salvation in various parts of the world. In northern Italy the steam railways have found it advantageous to install electric lines to secure the local traffic which was slipping away from them, while in various parts of the United States the extension of trolley lines from one town to another in the more densely population districts has shown fairly well the scope and limitations of electric traction.

The experience which has been gained in Ohio forms the subject of discussion in recent papers in the *Railroad Gazette* and in the *Street Railway Journal*, and from the comparative data thus available some interesting conclusions may be drawn, with all the advantage which practical experience offers over the dogmatic expression of opinion.

In the northern part of Ohio, with the city of Cleveland as a centre, there are a number of city and suburban trolley lines which, after various financial vicissitudes, are begining to show stabilty, and to demonstrate their capacity both as to the creation of new traffic and as rivals to the established steam railways.

Starting as city tramways, the electric lines of northern Ohio have developed into interurban railways connecting with numerous well-populated towns within distances of 30 to 50 miles; and, running upon the line of the existing highways they have built up a local business which is both profitable and instructive. While much of this business is undoubtedly new, a large part of it is taken from the local service of the steam roads. This is shown by the falling off in short-haul passenger traffic of the steam railways. Thus the Lake Shore & Michigan Southern carried in 1895 an average of nearly 17,000 passengers per month in its local service between Cleveland and Oberlin, while in 1902 this had fallen to 7,600 per month. A still greater difference appears in the business between Cleveland and Painesville and intermediate points, the monthly average falling from 16,600 in 1895 to 2,400 in 1902.

The absence of suitable records for the electric lines prevent a critical comparison with the figures for the steam roads. At the same time the records do show that the traffic over the Cleveland, Elyria & Western system, has increased from 950,000 passengers in 1899 to about 3,000,000 in 1902, so that there can be no doubt as to where the missing short-haul traffic of the steam roads has gone.

In some instances the diversion has practically amounted to the total traffic on certain portions of the steam railways, tickets

being purchased only when passengers need them for the purpose of checking baggage.

The question of fares has little or nothing to do with this remarkable change, since the difference is insufficient to make any such effect. The greater convenience of the terminal facilities of the electric cars gives them such an advantage that the steam roads make little or no attempt to compete, and admit frankly that they no longer have any real share in the interurban business within a radius of 10 to 15 miles of Cleveland.

The amount of business in an electric line which goes to the longer haul is difficult to determine precisely, and yet this is the exact portion of the question which measures the dividing line between the electric and the steam road. At the same time there are some general lines of information which indicate the limits. On the line between Cincinnati and Dayton, a distance of 57 miles, about 15 per cent. of the total business is through traffic, and the conditions are practically similar to those around Cleveland, and this may be taken as a fair estimate of the proportion of passengers who will be attracted by the lower rate of fare in spite of the greater time required for the journey.

It is very difficult to determine the amount of new business which has been created by the electric lines, especially in view of the frequent changes and reorganizations which have taken place since their installation. An idea may be obtained, however, from the fact that the total earnings of all the Cleveland traction lines has risen from $3,000,000 in 1896 to more than $6,275,000 in 1902.

The general effect of the development of interurban electric lines, running between large centres of population to good-sized towns within a radius of 30 to 50 miles, with their road bed on the side of highways passing through a well-occupied country, must be to divert the greater portion of the local traffic from the steam railways of the district. This is due very largely to the fact that the trolley car can be boarded at any point along the road and left at the place nearest to the rider's destination.

Many local travellers on steam roads have the inconvenience of passing close by their destination to a station several miles beyond, with no convenient means of connection, while the electric road, passing by the door, makes up in time more than the difference in actual running speed. The frequency of trolley service is also an important element in the question. When a certain train must be caught, as on the steam road, more or less time is always wasted in arranging one's affairs to fit the railway schedule, and frequently the inconvenience of a local railway time table far outweighs the greater speed of the train on the road.

An important feature of the interurban trolley lines is the transport of packages, this service being practicable at a lower cost and greater convenience than is possible on the steam railways. This again forms a department of business which has grown up almost independently of the steam railway freight and express traffic, since much of it consists of packages which would otherwise not have been sent at all. The whole work is in a line of industry largely of its own creating, and is an excellent confirmation of the adage that "facilities create traffic."

Viewed in the light of the experience which has been gained in the interurban electric systems of northern Ohio the relation of electric to steam traction may be fairly well determined. The steam railway will undoubtedly persist for a long time as the best and most economical method of handling long-distance business, say between points more than 100 miles apart. The local business can assuredly be conducted to better advantage, both for the carriers and the public, by the interurban electric railways, even as they are now operated, and when, with better road beds and more effective management a higher degree of efficiency is attained, we may expect to see the local trains to a great extent eliminated from the problem of steam railway operation. This cannot but conduce to far higher efficiency in the steam railway express service, and the advantages both for passenger and freight business of the longer haul will far more than compensate for the loss of the local traffic. When to this is added the impetus which the development of local industries must receive from the general advance in transport, it will be admitted that there will be a distinct gain, instead of a loss to the steam railways from the entrance of the interurban electric railway into the business of interurban transport.

RIVER-FLOW EXPERIMENTS.

AN EXPERIMENTAL TANK FOR THE STUDY OF THE ACTION OF CURRENTS IN THE FORMATION OF RIVER BEDS AND CHANNELS.

Engineering Laboratory at Karlsruhe.

MANY engineering problems contain so many variable elements that a satisfactory theoretical analysis cannot be effected without recourse to experimental determinations, and it is becoming more and more fully realised that the engineering laboratory is a necessary adjunct not only to the lecture room and study, but also to the investigation of the practical problems of the workshop and field.

The necessity of the testing tank for the investigation of the behaviour of ship models of various forms and speeds has been recognised by shipbuilders and governments, and now we have an extension of the experimental tank to the study of the action of currents in rivers as regards the erosion of banks and beds and the formation of shoals and channels.

A number of years ago the French engineers Darcy and Bazin employed a testing tank for the study of the flow of water in channels and over weirs, but their apparatus was arranged with an invariable slope, and without means for observing the action of the water upon the bottom and sides, and hence was available only for investigations of the velocity and discharge for a given slope. There has recently been constructed in the laboratory of the Polytechnic Institute at Karlsruhe, however, a very complete installation for the investigation of the action of the flowing water upon the channel, and from an account in a recent issue of *Le Génie Civil* and from the *Zeitschrift für Bauwesen* we abstract some account of the apparatus and its action. The tank, which is an improvement on one already built at Dresden, is made of sheet iron, and is 2 metres in width, 20 metres long, and 40 centimetres in depth, and is supported upon two girders in such a manner that its slope may be varied from zero to 1 in 50. In connection with the water supply there is arranged a rotary pump driven by electric motor so that a continuous supply of water may be kept flowing through the tank for any desired length of time, the discharge being returned to the suction of the pump.

The width of the tank is sufficient to permit the construction in sand of a channel of any desired sinuosity or curvature, the model stream or river bed being made of any desired width, and its banks formed of sand bags, or rammed sand, according to the nature of the experiments under consideration. In order to avoid the production of artificial currents in the miniature stream there is an arrangement of intercepting weirs at the delivery end of the tank by means of which all initial velocity is checked, and the flow of water is that due solely to the slope and volume, unaffected by any external influences. The water is delivered by the pump into an intermediate reservoir, from which it flows over a weir into the intercepting chambers at the head of the tank. The level of the water in the intermediate reservoir may be read at any time by means of a float and pointer, and from this level the discharge may be determined at any moment. A number of very precise determinations of the flow over the weir for various positions of the float have been made, and hence it is possible to observe the flow of water through the tank very accurately and to regulate it very closely at the rate determined for any desired experiment.

The manner in which a miniature river channel may be built up of sand is very clearly shown in some photographs which have been taken of the tank. By the use of sand of different degrees of coarseness the different kinds of soil may be imitated while dikes, breakwaters, and shore protection are built up of small bags containing leaden shot. The sand forming the river bed is smoothed off to a uniform depth before the water is turned on, and after the miniature river has been carefully filled with water the current is raised to the desired velocity and maintained for a sufficient period to enable the scouring action of the water to be observed. At the conclusion of an experiment the flow of water is stopped

by shutting off the current simultaneously at both ends, and the stream is emptied by draining so slowly that the changes which have been made in the bed by the current are exposed without being disturbed.

The entire equipment of the apparatus is most complete, there being bins in the basement beneath for the storage of sand, with a power bucket elevator for lifting and delivering the sand into the tank; and the facilities for manipulating all the variable elements which enter into a test are arranged in a very convenient manner.

The researches which may be carried on in such an experimental tank are numerous and valuable. Thus, the scouring action of a current on the concave side of a curve may not only be demonstrated but the laws governing such action may be studied by varying the curvature, the rate of flow and the character of the material. The sustaining power of water at different velocities may be made the subject of experimental investigation and the rate of deposit and manner of distribution studied. These, and many other problems may be investigated in such a laboratory, and there is every reason to believe that such experiments may be the means of directing the expenditure of the large sums of money devoted to river and harbour improvement so that the best and most economical results may be obtained in the design and execution of such important and costly works.

In addition to the investigations upon the action of water upon the banks and beds of streams, for which the apparatus at Karlsruhe is primarily intended, it may be employed to great advantage for the purpose of supplementing the investigations of Darcy, Bazin, and others upon the flow of water in channels, especially with reference to the influence of the form and material of the bed upon the mean velocity. In spite of the numerous investigations which have been made upon stream flow these questions are yet in the empirical stage, and it is only by subjecting theoretical deductions to the ordeal of experimental test, that true rational relations can be discovered.

MUNICIPAL TRADING.

THE COST OF CONDUCTING INDUSTRIAL UNDERTAKINGS BY MUNICIPALITIES AS OPPOSED TO PRIVATE ENTERPRISES.

Dixon H. Davies—Society of Arts.

IT seems to be generally admitted that there are certain things the conduct of which naturally belongs to the people collectively, and certain others which may be done by individuals, by joint-stock companies, or by municipalities, as circumstances may dictate, but it is extremely difficult to determine the dividing lines between such undertakings. Thus in practically all civilised countries the national government is universally conceded to be the only proper body to coin money, maintain highways, and to carry written letters. In others the government has the monopoly of telegraphic communication as well, but this somehow does not seem to follow everywhere. The tobacco manufacture is held sacred to government in some places, while railways, lotteries, salt, alcohol, opium, etc., etc., are well-known examples.

So far as municipalities are concerned, the monopolies which are most generally conceded to them besides those relating to government and the maintaining of order are those of water-supply, lighting and the maintenance of highways, although in many instances the two former are delegated to private companies, generally under the form of leases. In Great Britain, however, there is an increasing tendency for municipalities to enter into various kinds of commercial undertakings, especially the business of electricity generation and distribution. The wisdom of such proceedings, although advocated by some, is doubted by many, and the whole subject has recently been discussed in a very interesting and instructive manner by Mr. Dixon H. Davies, in an address upon the cost of municipal trading, delivered before the Society of Arts, and published in the *Journal* of the Society.

In considering the motive which impels municipalities to attempt such undertakings Mr. Davies shows that it may be traced, not to civic patriotism, but, in nearly all cases to self-interest, and in this respect is not different from any other kind of trading. The desirability of this sort of thing is in any case very questionable even if it is practicable, and it is far safer to trust to traders to interpret the commercial demand of a community than to rely upon the discernment of officials or of governors. Apart from any such considerations, however, the practicability of developing certain industries as they should be permitted to grow involves operations of greater magnitude than most municipalities are capable of conducting. An example of this is seen in the early history of steam railways. Ten years elapsed between the construction of the Stockton and Darlington Railway and the more ambitious undertaking between Manchester and Liverpool. Doubtless it would have been quicker to have had the work done by the Manchester corporation at that time, but the present enormous development of railways, involving an investment not far short of twice the national debt, would never have been made in that way, and the growth of British railways would have been badly hampered had their progress been confined to the conditions surrounding the growth of electric tramways and interurban railways at the present time.

"The power of private enterprises to expand is limited only by the demand, and the demand serves as an automatic stimulus and check always proportioning it like the governor of a steam engine, so that it neither races nor lags. Governmental enterprise is without this automatic adjustment. Its command of funds does not depend upon the success or failure of its undertakings, but upon the credit of the ratepayers. Industrial advance is not secured by the average opinion, but by the original thought of one or two men who take a line of their own, and prove themselves to be right before the stern tribunal of the market."

A most objectionable attitude of municipalism is that which will not permit independent enterprise to do that which it is unequal to carry on itself. As a consequence there is a slow stifling of trade, not apparent at any one time, but gradually operating to the detriment of the nation. It is estimated that as much as £400,000 has been expended by municipal authorities between 1892 and 1898 in opposing private projects in Parliament. Mr. Davies very rightly says that he can perceive little difference in such action and that of the trades unions in picketing a works in time of labor difficulties. The corporations are performing precisely the same function as the pickets in that they are continually seeking to deprive men of the opportunity of working according to their own choice of employment.

The position of municipal corporations in the conduct of such a business as the supply of electricity, for instance, is such as to render it much less safe in its methods of management. Thus is may towns no allowance whatever is made for depreciation, while "profits" are freely appropriated. It is argued that the sinking fund is a sufficient provision, and that no further deduction need be made. The period of the sinking fund ranges, however, from 30 to 50 years, while electric machinery has often to be scrapped in eight or ten years if a power or tramway plant is to be kept up to date. As Mr. Davies well remarks: "To neglect to provide for this antiquation out of each year's revenue, is simply to cheat the ratepayer of to-morrow out of his just inheritance for the sake of keeping things pleasant with the ratepayer of to-day."

In reply to the argument that the municipal system offers the only escape from the dangers of the trusts, Mr. Davies calls attention to the fact that the trust has presented itself as a serious difficulty only in countries in which the industries are subject to protection, so that the consumer is practically confined to the internal markets which can be controlled by combinations of capitalists.

"It is the protective support of the law which enables the capitalist to oppress the consumer. It is not the power of capital, but the legal monopoly which is the seat of the evil. In Great Britain (if we perhaps except water) there is no reason why there should ever be any other monopoly than the monopoly of superior efficiency. A tramway down one street can be paralleled by a subway or tube down another street. Gas,

which was at one time thought to be above competition, is now an alternative to electricity and petroleum. Hydraulic power has no monopoly. It shares its trade in many places with electric power, and in some also with pneumatic power supply. In private hands, the constant activity of invention, and the rivalry of commerce may be relied upon to secure in a free-trade country competition in one form or another, but the healthy stimulus and check of competition is always absent from an industry carried on by a municipal corporation."

The absence of control when the undertakings are in the hands of the corporations themselves appears in the absurdity of the borough authorities prosecuting the borough omnibus conductor, for instance, before the borough magistrate. The inconveniences of local boundaries and local jealousies are also cited as objections which disappear under competitive control, and altogether it is far easier to perceive objections than to discover advantages in the conduct of commercial undertakings by bodies originally derived for altogether different functions.

The great argument, that a corporation will have only the good of the citizen in view, while a company is run for the sake of making a profit, presumes that the two things are antagonistic to each other, while as a matter of fact the profit of the shareholders in a company is almost invariably secured by the charging of moderate prices in order to secure a large volume of business. Large profits are not obtained by charging high prices, but by wise management and by a large and satisfied clientele.

The proof of the disadvantages of municipal trading, however, lies in the slow progress of industries in Great Britain which, in other countries under the enterprise of private companies and active competition have attained phenomenal growth. Wherever open competition has been permitted, electric lighting, electric-power transmission, and electric traction have developed and prospered, and the communities have been correspondingly benefitted, but where, as in England, the industries have been checked and hindered by the incubus of municipal trading and municipal opposition, there has appeared a lack of progress which is entirely contradictory to British ability and British interests.

THE VIBRATIONS OF STEAMSHIPS.

AN EXHAUSTIVE STUDY OF SCIENTIFIC METHODS OF BALANCING MARINE ENGINES TO NEUTRALIZE THE VIBRATORY EFFECTS UPON THE HULL.

Rear-Admiral Melville, in Engineering.

WITH the great increases in speed and weight of marine engines there has arisen in late years a realisation of the necessity for providing, so far as possible, some satisfactory method of balancing the disturbing forces causing vibrations in the hulls of the vessels in which the machinery is placed. At one time the propeller was thought to be the chief source of vibratory disturbances, but the experiments of Yarrow upon a torpedo boat from which the screw had been removed, showed that by far the greater portion of the vibrations were due to the engines. The result has been a very general study of the possible methods of balancing marine engines, investigations having been made in England, Germany, and the United States which have been fruitful in practical developments.

In an exhaustive series of papers contributed by Rear Admiral George W. Melville, U. S. N., Engineer-in-Chief of the United States Navy to the pages of *Engineering*, the whole subject of balancing marine engines is discussed, together with a review of the work which has been done in the investigation of unbalanced or partially balanced engines in various parts of the world. Admiral Melville includes in his articles a study of the important papers which have appeared in Germany, including the investigations which have been undertaken by means of the Schlick pallograph, the whole forming a study of a problem which is of increasing importance in both the navy and the merchant marine.

As long ago as 1891 Naval Constructor D. W. Taylor, U. S. N., discussed the relation of the inertia forces and the crank angles, and showed that the unbalanced

force of the first period, i. e., occurring in a single revolution of the engine, was represented by the closing line of a polygon, the sides of which were parallel to the cranks, and the lengths representing the inertia forces of the corresponding cranks. From this has grown the Yarrow-Schlick-Tweedy system of balancing, in which the cranks of a four-crank engine are placed at such angles that the polygon with sides corresponding to the corresponding inertia forces will close.

So far as the balancing of the first-period forces of a marine engine are concerned, this method enables satisfactory results to be attained, and it has been extensively applied in recent large engines, notably those of German design, including, among others, the engines of the transatlantic steamship Deutschland.

Many engineers appear to assume that if the first-period vibrations are fully taken care of the problem is satisfactorily solved but Admiral Melville maintains that the vibrations of higher periods may in many instances become of such magnitude and importance as to demand attention, and he holds that no system of balancing can be accepted as entirely satisfactory which does not provide for all the higher-period vibrations.

In order to show the existence and importance of the higher-period vibrations, Admiral Melville analyses a number of pallograms, or autographic records of hull vibrations, as recorded by the ingenious instrument, the pallograph, devised by Schlick, the German engineer, for the study of the subject. This instrument has been in regular use in the German navy since 1893, and the researches published by Imperial Naval Constructor Berling, Herr Mohr, and Naval Constructor Köhn von Jaski render a large amount of material available for the scientific investigation of the question. In studying these short-period vibrations Admiral Melville points out that the measure of their importance may be taken as the product of the force by the frequency, in which light some instructive facts are deduced. When the pallogram, or waved line drawn by the instrument under the influence of vibrations, is found to be a pure sine curve it represents vibrations of a single period. When, however, the waves depart from the sine curve, and show notches, crests, and hollows, it is evident that they are the resultants of vibrations of several periods, and it is possible to analyse the diagram and determine the simple elements of which it is composed. This Admiral Melville has done very effectively in his paper, to which the reader must be referred for the detailed analysis. It is sufficient to state here that in important examples the second period vibrations are found to be more important than those of the first period, and moreover the attempts to secure a balancing, by the Yarrow-Schlick-Tweedy system, of the first-period vibrations resulted in a marked increase in those of the second and higher periods.

Under these circumstances Admiral Melville does not accept the method of unequal crank angles, as advocated by Taylor, Schlick, and others, as the best method of balancing marine engines, but prefers the system of Macalpine, in which the two pistons of two cylinders are connected to opposite ends of a beam, the connecting rod being attached to one end of the beam and there being but two cranks for four cylinders. By this construction all the reciprocating forces may be neutralised by other equal forces acting in the opposite directions, while a moderate counterpoise on the crank enables the revolving weights to be balanced.

When it is admitted that the unequal angles of the cranks of the Yarrow-Schlick-Tweedy system do not effect a complete balance for vibrations of all periods, it is in order to examine the effect which the departure from cranks at right angles produces upon the turning moment upon the shaft. There has been a difference of opinion in this respect among naval engineers, but the best that can be said is that under certain circumstances the uniformity of the turning moment may not be seriously impaired by the departure from right-angled cranks. The torsional vibration period of the shaft enters into this portion of the problem, and the relation of the vibration of the shaft to the rotative speed of the engine must be considered. For the solution of this portion of the question both forms of engines may be proportioned without material advantage or disadvantage on either hand, so that the question of balancing engine vibra-

tion of all periods still remains the important feature. Certainly the arrangement of unequal crank angles is at no especial advantage in this respect, and since it has been shown to be defective as regards higher-period balancing it is the inferior method in any case.

Admiral Melville has given, in these important papers a fuller examination of one of the most important questions in marine engine design, than has been elsewhere available, and his views will doubtless be discussed in marine engineering circles on both sides of the Atlantic. Apart from the manner in which the problems under consideration are dealt with, however, his articles seem to furnish a most powerful argument for the abandonment of the reciprocating marine engine as soon as it can possibly be done. Higher speeds are demanded, and hence the evils of vibration must increase unless the steam turbine, in some form, can be made acceptable for marine use, and with the experience which has been had with smaller vessels it certainly seems as if larger applications might be made with safety and success. Prevention is certainly better than cure, and instead of providing methods for balancing the inertia forces of reciprocating parts those parts should be abandoned, and engines involving pure rotary motion only be introduced.

STEEL CASTINGS.

LARGE STEEL CASTINGS FOR ENGINEERING WORK AS EXEMPLIFIED IN THE WORK SHOWN AT THE DÜSSELDORF EXPOSITION.

Bernhard Osann—Stahl und Eisen.

WHILE cast iron has long been deemed unsuitable for situations in engineering structures in which great and varying stresses occur, the facility with which it can be formed into difficult and complicated shapes by the operation of melting and pouring into moulds has made its use general in situations to which the character of material is not altogether suited. With the development of the various processes for the manufacture of steel, however, many attempts have been made to unite the resistance and elasticity of steel with the ability to form it by casting in moulds, and at the present time many of the difficulties which were at first encountered have been overcome.

In an address recently delivered before the Eisenhütte Oberschlesien at Gleiwitz by Herr Bernhard Osann and published in *Stahl und Eisen*, the progress which has been made in recent years in the production of steel castings is discussed, the present state of the art being illustrated by the many important exhibits shown at Düsseldorf last year.

The earliest attempts at the productions of steel castings were made with crucible steel more than fifty years ago, and notwithstanding the development which has followed the introduction of the open-hearth process, crucible castings are still made for small articles. It is only during the past 10 or 15 years, however, that the commercial production of steel castings of large size has been fully developed, and today the work is confined to comparatively few establishments in which the necessary skill and experience have been acquired.

To the uninitiated the production of castings from steel may appear as simple a matter as the pouring of cast iron, but the materials are altogether different in behaviour. Much careful experimentation was necessary to enable a sufficiently soft material to be produced, and to make castings free from blowholes and shrinkage cracks involves great care and skill in the foundry. Herr Osann gives much credit to the Krupp works for the development of the steel casting industry, and calls attention to the fact that in the Krupp catalogue of 1887 announcement was made that the firm was prepared to furnish large castings of soft low steel having an ultimate resistance of 40 kilogrammes per square millimetre, with an extension of 20 per cent.

The manner in which the difficulties have been overcome, and the splendid work shown at Düsseldorf produced, Herr Osann discusses at length. So far as the quality of material is concerned, it depends largely upon the character of the pig iron from which the steel is made, the slightest traces

only of phosphorus, sulphur, and copper being permissible. The tendency of soft material to form cooling cracks, owing to the great contraction on solidification, increases the difficulty in the production of perfect castings. Cooling cracks are not uncommon with soft cast iron, but the shrinkage of low steel is nearly double that of cast iron and hence the difficulties are much greater. The question of cooling and shrinkage is especially important in the case of large and intricate castings, such as the stern and rudder posts for screw steamships, large gear wheels, locomotive frames, and the like, examples of which were shown at Düsseldorf. The general employment of steel castings for pole pieces and armature rings for large dynamo-electric machines has made it necessary to produce pieces of difficult form, and in all of these the question of shrinkage cracks must be met.

To a large extent the designer can assist in providing satisfactory results. Shapes which would be entirely practicable in cast iron are altogether unsuited for casting in steel, since the junction of portions of greatly different volume and section causes such unequal contraction as to produce se vere shrinkage strains.

The designer must understand the necessity of maintaining uniform sections of adjacent parts, or of merging one section gradually into another without abrupt changes or sharp angles. Where additional strength is required it should be obtained by the addition of ribs instead of increased general thickness, and the dimensions of some parts may be made greater than the requirements of mere strength in order to maintain fairly uniform thicknesses of metal in the casting.

The absence of cracks in the finished casting is by no means to be accepted as assurance of the absence of internal shrinkage stresses. It is altogether possible that some portions of the casting may be subjected, by reason of contraction, to internal stresses very nearly equal to the resistance of the material, so that fractures may appear upon the application of small external forces, especially shocks or blows. For this reason it is important that the casting should be annealed by raising it to such a temperature that the molecules may have an opportunity to rearrange themselves. Experience has shown that the annealing temperature is bounded by somewhat narrow limits, ranging between 800° and 900°C.

At the Krupp works the temperature is very carefully determined by the use of the Le Chatelier pyrometer, the annealing furnace being so arranged as to produce as nearly as possible a uniform temperature in all parts.

An important element in the production of perfect steel castings is the provision of an ample number of gates and vents in the mould, so that the casting may be poured at a large number of points at once and the flow of metal in the mould may be free and prompt.

If the mould it not rapidly and completely filled the thinner portions, webs, ribs, etc., will begin to solidify and contract before the thicker parts of the mould are filled, and even with the greatest promptness and rapidity of manipulation unequal cooling is apt to occur. A study of the cooling curves of the metal upon specimens of various thicknesses will enable the effect of the pouring to be observed and will permit the disposition and number of gates necessary to be determined.

It will be seen that a large part of the success attained by makers of steel castings is due, not to any especial process or material, but rather to the exercise of the greatest possible skill and judgment in the conduct of the work. Hard and fast rules and methods will not do, since each piece must be treated according to its peculiarities. That this can be accomplished within the limits of commercial success is shown by the extent to which steel castings are coming into use for important portions of machinery in which no risk of failure can be permitted. Herr Osann includes in his discussion sketches of sole plates and upright frames for marine engines, single castings weighing 3 and 4 metric tons, while rolling-mill castings of more than 25 tons have been successfully made. Pieces which could not be made of forgings because of the great expense involved, are readily produced in steel castings, and there is every reason to believe that with increasing experience both on the part of the designer and the steel founder, the employment of steel castings will be greatly extended in all departments of engineering construction.

PRACTICAL APPLICATIONS OF METALLOGRAPHY.

DETERMINATIONS OF THE PHYSICAL STRUCTURE OF STEEL IN CONNECTION WITH PROCESSES OF MANUFACTURE.

Albert Sauveur—Engineers' Society of Western Pennsylvania.

AMONG the many advances which have been made in the study of materials of construction one of the most recent is the application of the microscope to the examination of the physical structure of metals, the science of metallography, as it has been named after the analogy to the kindred science of petrography, the microscopic study of rocks. The general nature of the methods and results of the science of metallography were discussed by one of its leading exponents in America, Mr. Albert Sauveur in the issue of this Magazine for September, 1899, and now we have a lecture upon the subject by Mr. Sauveur, delivered before the Engineers' Society of Western Pennsylvania, and published in the *Proceedings* of the Society.

The practical man may well be excused for inquiring how the examination of a minute portion of the surface of a piece of iron or steel can convey any useful information as to its value for rails, or buildings, or machinery, and may be reasonably incredulous when he is assured that the study is eminently practical in its character.

At the same time Mr. Sauveur showed very plainly to an audience of intensely practical men, in the heart of the greatest steel producing centre of the world, that metallography must soon be allied with chemical analysis and the work of the testing machine in determining not only the character of their products after they are made, but also the best methods to be employed in the course of manufacture.

It is impracticable here to go into the details of the study of metallography, for these the reader must be referred to the papers of Mr. Sauveur and other specialists. Broadly, the method consists in polishing a small portion of the surface of the metal to be examined, so as to render it free from any surface markings or characteristics, and then treating this surface with acids or other substances, such as tincture of iodine, which etch or eat the various constituents to a different degree, rendering their occurrence and distribution visible. When such a polished and etched surface is examined under the microscope, the magnified portion shows to the experienced eye the arrangement of the particles of the metal in a manner which reveals many facts not otherwise ascertainable.

Thus steel, which the chemists can tell us only is composed of iron and carbon in certain proportions, is shown to exist with the iron and carbon arranged in different structural forms according, not only to their relative proportions, but also to the manner in which it has been subjected to the action of heat. The pure iron, or ferrite as it is called, is readily distinguishable when it occurs by itself. The carbon combined with iron as carbide appears in another form, known as cementite, while the mechanical mixture of the two, called pearlite, is also to be perceived by the eye. The relations between these important elements in steel, together with others of less conspicuous character, have much to do with the value and character of the steel as a material of construction, and if these relations can be determined by such simple operations as those of metallography, the practical bearing of that study becomes apparent.

Here the combination of microscopy and photography enters into the work, since it is possible to photograph the magnified images of the polished and etched sections so clearly as to enable comparisons to be made with any surface under examination and those which have been previously studied and photographed. This ability of preserving a permanent record of the result of any metallographical examination constitutes a valuable feature of the method, and one which should appeal to the practical man.

At the present time the microscopical examination is not available for the detection of the presence of phosphorus or sulphur, and hence it should be used in connection with chemical analysis, but this combination of the two methods of research enables far more to be learned than would be possible by the use of either separately. Thus

Mr. Sauveur showed a number of photographs taken from various portions of the section of a steel rail, showing very clearly the difference in structure in the different parts, although the chemical composition of the rail, considered as a whole, was doubtless within the limits prescribed by chemical requirements.

Mr. Sauveur discusses some of the objections which have been advanced in opposition to the introduction of metallography in the steel works, in a very effective manner.

"Many people argue that the knowledge of the structure of the metal is of little importance, and that if the metal is defective the testing machine will show it at once. To show how foolish this reasoning is, one might as well say that he does not care for a chemical analysis of steel, since if it be defective the physical test will demonstrate that fact. It is evident to every one that this is not the right view of the matter. The testing machine reveals the basic fact that the metal is defective without indicating the cause, much less suggesting a remedy. We want to know why it is defective. If it is defective, we want to know whether it is due to defective composition or to defective treatment, and the correct structure is just as important as the proper composition. It is just as important to know that a steel is not of too coarse a structure as it is to know that it does not contain too much phosphorus. The lack of ductility and the brittleness caused by a coarse crystallization is just as objectionable and is to be guarded against with just as much care as the brittleness caused by too high a percentage of phosphorus."

A very important feature in connection with the use of metallography in connection with steel manufacture is the extent to which it can be employed to check the heat treatment to which the metal has been subjected. Thus it is well known that rails should be rolled at a fairly definite temperature to obtain the most satisfactory results, but under ordinary circumstances it is very difficult to determine at what temperature a certain rail has been rolled. By making a microphotograph of the metal of the rail, however, and comparing it with a set of photographs of steel of the same composition taken at different temperatures it is possible to approximate very closely at any subsequent period to the temperature at which a given piece of steel was worked, and thus written records and verbal statements may be independently checked.

THE PHOTOMETRY OF ELECTRIC LAMPS.

EXISTING STANDARDS OF ILLUMINATING POWER, THEIR DEFECTS AND POSSIBILITIES, WITH SUGGESTIONS FOR IMPROVEMENT.

Dr. J. A. Fleming—Institution of Electrical Engineers.

ARTIFICIAL lighting has passed through almost as long a list of changes in the course of human history as any of the means by which man has converted the forces in Nature to his use and convenience, following closely behind the introduction of fire, with which, indeed it is still generally associated. It is not surprising, therefore, that some primitive ideas should still persist, even in the most scientific departments of its applications, and that the candle remains as a nominal standard of illumination. Now, however, it is beginning to be realised that something more precise than "candle power" is appropriate for the unit of measurement of light, and there have been numerous discussions in the past few years concerning the best methods of measuring, comparing, and recording the effects of illuminating appliances.

In a paper recently presented before the Institution of Electrical Engineers, Dr. J. A. Fleming discusses the whole subject in a very interesting manner, and some abstract of his address is here given.

Without attempting to consider the profound subject of photometry, every individual recognises the natural standard of daylight and mentally compares artificial lights with this standard. Instinctively one realises that a light possesses various qualities, and that the brightest light does not always furnish the most effective illumination or show true colour relations. Dr. Fleming considers these questions

from the true scientific standpoint, showing the methods which are practically available, and including many valuable suggestions as to the establishment of standards of comparison and reference.

Considering first the question of standards, Dr. Fleming examines flame standards and incandescent standards, used both for reference and for working purposes. Of the flame standards the most important are the colza oil or Carcel standard, still used in France in practically the same form originally given to it by Dumas and Regnault; the Vernon-Harcourt pentane lamps, now the official standards for London gas testing; and the amyl-acetate lamp of Hefner-Alteneck, the legal standard of Germany. Of these Dr. Fleming considers the Vernon-Harcourt lamp the best, but believes that flame standards in general possess material disadvantages. In order to insure the uniformity necessary for a standard of light the greatest care is necessary to secure purity in the fuel burned, and during the photometric work the flame is affected by external variable conditions, such as the purity of the air, the barometric pressure, the action of draughts of air, etc. In the case of the Hefner-Alteneck lamp the reddish colour of the flame renders it unsuitable for use in heterochromatic photometry, or for the photometry of arc lamps. It is therefore extremely desirable that some other standard than that of a flame of any kind should be devised.

The standards of incandescence which have been used consist either of platinum or of carbon. The platinum standard of Violle involves the use of a unit of light consisting of the amount of light radiated normally from one square centimetre of platinum at its melting point. Although this unit has been the subject of adverse discussion, Dr. Fleming is disposed to accept it as an ultimate reference standard, providing satisfactory working standards can be derived from it. The experiments of Petavel have shown that the platinum standard can be made successful if the metal used is a mass of not less than 500 grammes, chemically pure, heated in a crucible of pure lime by an oxyhydrogen blowpipe, the hydrogen containing no hydro-carbons, there being a supply of three volumes of oxygen to four of hydrogen. The platinum is fused and then allowed to cool, and from the moment freezing commences until solidification is completed the light emitted is constant, being observed through an opening of one square centimetre in a water-cooled screen. Obviously such a standard is suited only for a physical laboratory, but may well be employed for standardising working standards of more convenient form.

For a working standard Dr. Fleming suggest a certain form of incandescent electric lamp, devised by him to remove the variability of the ordinary glow lamp. The ordinary incandescent filament increases somewhat in candle power for a short time, owing to changes in resistance, but after about 50 hours it becomes practically constant. The further deterioration in the illumination power of the lamp arises mainly from the deposit of particles of carbon upon the inside of the bulb, the blackening obstructing the passage of the light. Dr. Fleming has found that this blackening can be greatly reduced by the use of a much larger bulb, and hence he suggests as a convenient working standard an incandescent lamp of which the filament has been used in an ordinary bulb for about 50 hours, and then removed and placed in a large bulb. Such lamps, if used only for the short periods required in photometric work will maintain their constancy for a long time, when operated at the voltage for which they are marked. By using the Violle incandescent platinum standard as a reference for calibrating such standard glow lamps, therefore, a system of scientific photometric standards may be obtained which offers material advantages over those now in use.

Dr. Fleming discusses at length the different forms of photometers now in use and indicates his preference for the Lummer-Brodhun type, in which the lights from the two sources to be compared impinge upon opposite sides of a slab of white magnesia and are then reflected through prisms into a telescope where their intensities can be visually compared. In the use of this or of any form of photometer the necessity of excluding all external light is emphasised and the inadequacy of many existing arrangements pointed out.

When flame standards are employed especial care should be taken to have the pho-

tometer room well ventilated, and examples are given to show the effect which the presence of a number of persons in an imperfectly ventilated room had upon the uniformity of a Vernon-Harcourt pentane lamp.

The practical methods of setting out the polar curves showing the radiation of light from a lamp in different directions are described, and some very serviceable directions given as to the use of such information with respect to the setting out of lamps in street lighting. The important subject of photometric units is also discussed, and the suggestion is made that a convenient unit would be 10 candle power, to be called cne lamp.

Dr. Fleming's paper is filled with useful and valuable information concerning the details of photometric work in connection with electric lighting, and it should be the cause of further discussion upon some of the subjects which he has agitated as demanding study and settlement.

THE GRADING OF PIG IRON.

CHEMICAL AND PHYSICAL TESTS AS COMPARED WITH GRADING BY FRACTURE IN THE SELECTION OF IRON FOR THE FOUNDRY.

Dr. Richard Moldenke—American Foundrymen's Association.

THE question of the strength and suitability of materials of engineering construction is being studied more and more, and the present tendency is to carry the practical investigation of materials back several stages beyond the state in which they enter into the completed structure. Thus the properties of the group of materials known under the generic name of steel have been traced back to the constituents of the pig iron, the furnace lining, the materials added in the converter or open-hearth furnace, the heat treatment, and other elements in its preparation and manufacture. In like manner the nature of cast-iron products is held to be largely dependent upon the character of the pig iron fed into the cupola, and this again upon the character of the ore, flux, and fuel delivered to the blast furnace. It has well been said that the raw material of one industry is the finished product of the other, and thus no product is entitled to be called raw from the moment that the hand of man has been laid upon it to apply it to any useful purpose.

The extensive use of cast iron in all departments of engineering work renders it especially important that definite results should be attained within reasonable limits concerning the strength and character of the products of the foundry cupola, and hence the necessity of grading the pig iron which forms the principal supply of material for the cupola has long been appreciated. The old method, that of grading pig iron by fracture, has been found unreliable, since the appearance of the fractured end of the pig is now known to be dependent upon the rate of cooling and other considerations besides quality and composition, and hence various methods have been suggested to permit a more accurate knowledge to be obtained.

This whole subject has been made the subject of extensive study by Dr. Richard Moldenke, and at the convention of the American Foundrymen's Association last summer he made a proposition to establish standard methods of foundry operation in order to obtain accurate information concerning the various elements which affect the character of the castings produced. We now have a second paper upon the subject by Dr. Moldenke in the *Journal of the American Foundrymen's Association*, discussing various elements in the valuation of pig iron for foundry purposes in an interesting manner.

It is now well established that chemical analysis is the most reliable method of determining the character of pig iron, and there appears to be a general willingness of dealers to sell pig iron by analysis. This is a great advance over the reliance upon brands and fractures formerly so general, but chemical analysis should not be the enter reliance of the foundryman.

Mr. Robert Buchanan, in his paper in the last issue of this Magazine, shows very forcibly the advantages of chemical analysis for the grading of pig iron over the old meth-

od of inspection of fracture which the foundryman thinks is sufficient.

"All the furnacemen on record think that selling pig iron by analysis is sufficient. They do not, however, realize that the roll maker, the founder of car wheels, the maker of malleable castings for specified tests, use several brands of the best irons obtainable, all of the proper composition, for safety; and when, in spite of this and the greatest care everywhere, the rolls crack, the car wheels fail to pass, and the couplers will not stand up, first one brand of iron is cut out and then another, and thus the hitherto unsuspected iron is weeded out. Doubtless this iron might be a very good one generally, but if the foundrymen had the means of knowing that his shipments were made while the furnace was under a cloud, he would rather give away the iron than put it into large rolls. Such irons, while showing the right composition, might be so badly burned in the making that normally strong pigs will break in two, by simply letting them fall on a rail. The cupola and the hearth furnaces are not the only places where iron can be badly oxidized, but this is very difficult to trace chemically."

When the strength of the castings is a matter of essential importance the chemical analysis should be suplemented by the physical test, made, not upon the pig, but upon standard test bars run from the cupola. Upon the combination of these two tests Dr. Moldenke thinks the ability to obtain standardized and reliable results depends. The chemical analysis shows what has been put into the cupola, and the results from the test bar reveal what has come out of it.

As regards the practical working of the physical test in addition to the chemical one, it will probably come about by the willingness of the founder who desires to have a guaranteed test strength to pay for it. This the founder of rolls, car wheels, malleables, government work, special machinery, and other castings requiring the highest grade of material will be glad to do. Wherever castings are made upon the strength and quality of which human life depends there should be no question of price in any case.

"It is further held that the physical strength is not enough, but that shrinkage, scrap carrying capacity, clean and sharp surface, and the microstructure of the iron should be arranged for. This I consider entirely too elaborate, and in fact unnecessary so far as we know now. The plain transverse test is all that is necessary to show what is required when taken in connection with the composition. The contraction of an iron when in the standard test bar, is practically a matter of its composition, and that mostly in the constitution of the carbons. With the large standard test bars, adopted by the American Foundrymen's Association, the influence of the pouring temperature and the molding sand is practically eliminated, leaving the question of contraction of much less importance than was formerly thought to be the case. Of course in the absence of chemical data a contraction test is very essential, but we are beyond that point at the present day.

The practice of selecting pig iron by chemical analysis and then checking the result by physical tests of the product, should, if systematically carried out, result in the collection of a large amount of valuable information concerning both iron and foundry practice. An iron which has given consistently good test results would reveal defective work in the foundry if the test bars began to make a poor showing, and conversely a variation in foundry practice might show means for improving the product of mixtures formerly misjudged. So much is dependent upon the maintenance of accurate records of sufficient experience that the main thing is to secure the adoption of some degree of standardization in order to secure records from which reliable conclusions may be drawn.

"It is admitted that poor foundry practice, bad fuel, or even variations in the regular routine will bring about variations in results with the best of irons, that the character of the castings made from pig iron depends upon many conditions, but the fundamental idea remains that with good standards and fair conditions, a good iron should show up well in a remelting test. What the actual strength should be will soon be developed by the foundryman most interested, and gradually pig irons, while varying in composition from month to month, or day to day, as they come from the furnace, will not vary as much in corresponding quality as they do now."

TESTS OF REINFORCED CONCRETE.

INFLUENCE OF THE DISTRIBUTION OF THE IMBEDDED METAL UPON THE STRENGTH OF REINFORCED-CONCRETE BEAMS.

Beton und Eisen.

ONE of many examples of the growing interest which is had in the use of reinforced concrete as a material of construction is the fact that a journal devoted entirely to the subject is now published in Vienna, the title being the significant one of *Beton und Eisen,* and the editor being the well-known engineer, Herr Fritz von Emperger. Although issued in Vienna, articles in this new journal appear in French and English as well as in German, in some instances papers appearing in more than one language simultaneously, in parallel columns.

In a recent issue of *Beton und Eisen* there appears several papers giving the results of tests upon beams of reinforced concrete, these showing very clearly the influence of the position of the metallic reinforcement with regard to the stresses upon the member.

Thus a series of tests were made in Holland by Sanders upon T beams of reinforced concrete, the heavier reinforcement being in the form of round rods imbedded longitudinally, and tied in to the body of the beam by means of lighter metallic stirrups. Tests were made upon two kinds of beams, the one having the flange uppermost and the other with the flange below, the rods in each case being imbedded in the lowermost portion. The dimensions of the beams were 300 millimetres deep by 200 millimetres wide, with a flange 500 millimetres wide and 60 millimetres thick, the length being 6 metres. The main reinforcement consisted of 4 round rods of steel of 20 mm. diameter, with stirrups and skeleton construction of rods of 4 to 8 mm. in diameter uniting these with the mass of the beam. The concrete was composed of 1 part of cement to 2 of sand and 2 of gravel, mixed rather wet, as is desirable for such work, and allowed to set and harden for two months prior to the testing. The tests were made by direct loading with pigs of iron, the load being uniformly distributed, and the deflections noted until rupture took place. The character of the ruptures is clearly shown by photographs, which indicate that failure took place in both types of beam by the crushing of the concrete the upper portion of the beam breaking down, and the light rods there imbedded buckling. Under such circumstances it is evident that greater strength would be obtained by increasing the section upon the compression side of the neutral axis, and that the beam which had its greatest section in that relation would prove the stronger. This view is confirmed by the tests, since the beam in which the flange was placed uppermost sustained a load of 13 metric tons before rupture, with a deflection of 37.5 millimetres, while with the flange below the rupture occurred with 10 ton, and at a deflection of 33.5 millimetre.s

In considering these tests it may be of interest to compare a series which were made at the Polytechnic School at Zürich by Professor Schüle, an account of which is given in the same issue of *Beton und Eisen.* These beams tested were reinforced according to the Hennebique system, with rods near both the top and bottom surfaces and with stirrups tying them into the body of the concrete. These were smaller than those tested by Sanders, being of rectangular section, 300 mm. high and 200 mm. thick, with a length between supports of 1.5 metre. The tests were made in an Amsler testing machine, the pressure being applied from a hydraulic plunger in the middle of the beam, and the deflections observed by a mirror apparatus of the Bauschinger type. The reinforcement in these beams consisted of four rods, of 15 mm. diameter in the upper portion and four in the lower portion, two of the rods in each portion running straight along the length of the beam, and two passing to the opposite surface and back again, thus acting as suspension members whichever edge of the beam was placed uppermost.

The object of the tests was to confirm, or otherwise, the relation of the deflection to the loading, in order to observe whether Hooke's law was maintained. Since the

extension was demonstrated to increase made rapidly than the loads it became evident that the law of elasticity did not obtain, and hence the maximum efficiency of the material was not attained with the proportion or disposition of material.

It has been suggested that the true method of reinforcing concrete with imbedded metal should be that of distributing the reinforcement in the lines of tension as they exist in a beam subjected to the given loading. The locations of these lines are fairly well known, and indeed such a disposition of material was fairly well indicated in some of the earliest constructions in the original patents of Monier, as long ago as 1878.

The use of the methods of reinforced concrete for the manufacture of beams, to be transported to the place of erection and there employed much after the manner of beams of timber or metal appears to be a use of the system altogether aside from its principal characteristic advantage. The chief merit in the system really should lie in the ability to manufacture a structure on the spot which should, when completed be practically monolithic, the imbedded metal forming not only the reinforcement, but also the skeleton upon which to mould or pour the concrete. From this point of view, the experiments with beams may prove of interest and value as indicating the right proportions and disposition of material, but it should not be inferred that the formation of separate members for subsequent incorporation in structures at a distance is the best application of the methods.

MODERN GRINDING MACHINERY.

THE RIGHT USE OF GRINDING WHEELS IN MACHINE-SHOP PROCESSES—WORKING SURFACES AND SPEEDS.

Verein Deutscher Ingenieure—American Machinist.

GRINDING processes are now becoming so generally employed in the machine shop for finishing all kinds of metal surfaces that such work is beginning to demand as much attention as other methods of precise machining. Doubtless much of the accuracy and perfection of ground work depends upon the machines in which the wheels are used, but it is important that the right kind of wheels should be used, and that they should be operated at the proper speeds.

In a recent issue of the *American Machinist*, Mr. C. H. Norton gives some timely points about the use of grinding wheels, and in the *Zeitschrift des Vereines Deutscher Ingenieure* we note a report by Professor M. Grübler upon experiments recently made upon the strength of emery and carborundum wheels to resist the stresses due to centrifugal force.

Mr. Norton calls attention to the too common error of assuming that there is a proper lineal speed at the periphery at which the grinding surfaces of emery wheels should be run, and that therefore the rotative speed is governed entirely by the diameter of the wheel. Again, it is a common error to assume that to produce a fine finish the grain of the wheel must be as fine as that of the surface desired. As a matter of fact the character of the work produced is a resultant of several elements including grade of wheel, speed, depth of cut, speed of work, surface, etc., and all of these should be taken into account if the work is to be of the character desired and performed to the best advantage.

The idea that there are wheels so constructed that all materials can be ground equally well with one and the same wheel Mr. Norton aptly compares with the theory that is advertised by certain patent-medicine vendors, that one remedy can cure all human ills, and the two propositions are about equally far from the truth.

Wheels are constructed which will grind all materials, but as to grinding them all equally well, that is another question. When the proper wheels are used the work will be better done, time will be saved, and greater satisfaction attained. Many mechanics feel that the time required for changing wheels for various jobs will consume more time than will be saved by using the proper wheel, but Mr. Norton cites several examples to show that even for a single piece of work there is a time advan-

tage in using the proper wheel, while if a number of pieces are to be ground the time of changing may become negligible. In this respect the grinding process should aid in systematising shop work, since the gain by classifying work so that a large lot of pieces of one kind are ready for grinding at one time, is a sufficient inducement to encourage the working of parts in lots, to the general gain of the passage of the whole through the works. When a wheel which is unsuited for the work is employed the truth of the surface may be materially affected. Thus if a coarse, rapid-grinding wheel, suitable for use on cast iron be used for soft steel on light work the pieces will be very apt to be ground out of truth, the frail work not being able to stand the rank cut of the soft wheel on the soft material. A harder and more compact wheel will then not only do the work better, but perform it in less time as well.

The most important point brought out by Mr. Norton is the fact that grinding should be considered as a special and precise shop process, and as such should be given the same special care and supervision as is now demanded for every machining process in the well conducted modern machine shop. In other words, the man who tends the machine should have nothing to say whatever about the character of wheel, its speed, or the manner in which it should be used. All these questions should be under the care of a single expert, whose duty it should be to direct the use of the wheels, and see that they are properly employed in the same manner that the tool-maker in the modern shop attends to the automatic screw machines, turret lathes, and other standard cutting tools. The machinist should find his work in attending to the running of the machines, not in grinding tools and setting them to the especial angle which may suit his fancy, this latter work being done in the tool room according to carefully predetermined methods, and taken out of his hands altogether. The same should be true of the grinding wheels, and when such skilled supervision is given to the right use of the grinding machinery the time required to perform each piece of work can be determined and allotted to the machinist for any bonus, premium, or piece work system which may be adopted, with the assurance on the part of the employer and the workman alike that it is fully within the capacity of the machine.

The paper of Professor Grübler discusses a number of experiments made upon wheels of various kinds, in order to ascertain the resistance to bursting. The apparatus, which shows much ingenuity in design, consisted of a vertical spindle running in bearings supported upon beams over a pit, the wheel being placed on the end of the spindle suspended at a sufficient depth in the pit to prevent any possibility of accident from flying pieces of bursting wheels. An accurately calibrated speed indicator was connected to the upper end of the spindle, this enabling the speed at any moment to be observed, while at the same time a permanent speed record was made, the two checking each other within small limits of error. The spindle was revolved by rope connection to a four horse power electric motor, with suitable switchboard appliances, the whole being entirely under control of the experimenter.

A number of wheels were tested to destruction in this apparatus the data and results being fully tabulated in the original report, and some general conclusions only are here given. The wheels tested were divided into three classes, according to the character of the binding material by which the abrasive was cemented into form. These included compositions using a vegetable binding, usually some kind of gum; or a mineral binding, principally magnesia cement; or a ceramic composition, similar to a porcelain, the moulded wheel being subjected to a white heat. The only wheel not coming under this classification is that made by the Tanite company, in which an animal binding is employed, made from leather residues.

So far as rated speeds were concerned the makers of the wheels using a vegetable binding offered the highest, one firm permiting peripheral speeds of 25 metres per second (4,920 feet per second) while wheels with a mineral binding were rated at a maximum speed of 15 metres per second, (2,952 feet per minute). As a matter of fact, however, both kinds of bindings showed high resistances in the tests, the bursting speeds ranging from 70 to 110 metres per second (13,776 ft. to 21,648 ft. per minute).

The highest bursting speed tabulated by Professor Grübler was that attained by a carborundum wheel, with a ceramic binding, this bursting at a peripheral speed of 114.21 metres per second (22,476 feet per minute).

Professor Grübler's paper contains much valuable information concerning the conditions upon which the strength of grinding wheels depend, and not the least interesting of the results of the tests is the general high character of the wheels tested, representing prominent German and American makers. With wheels properly mounted there should be no hesitation about running them at speeds indicated by their makers, so far as bursting resistance is concerned, and hence the question of speed may be decided by conditions of efficiency governed by the nature of the work.

THE MERCURY-VAPOR TUBE.

EXTENDING APPLICATIONS OF THE COOPER-HEWITT MERCURY-VAPOR TUBE AS A CURRENT RECTIFIER AND INTERRUPTER.

Electrical Review.

THE mercury-vapor lamp of Mr. Peter Cooper Hewitt is well known as a successful device for obtaining illumination from the electric current with a much lower expenditure of electrical energy than has been attained with the incandescent glow lamp. The device consists of a glass tube of any shape which may be desired, provided with a bulb at one end filled with mercury. The tube is exhausted of air, a negative electrode fixed in the mercury-bulb end, and a positive electrode at the other end. Upon the passage of a continuous current the tube, filled with mercury vapor, emits a brilliant light, and tests have shown that the consumption of electrical energy is only about one-seventh that required to produce an equivalent illumination with the ordinary incandescent lamp. The principal objection which has been advanced to the mercury-vapor lamp is the absence of red rays, this giving a peculiar aspect to everything in which that color should appear, but the absence of these rays removes a source of irritation to the human eye, and hence this defect is not altogether objectionable.

Upon experimenting with this lamp the principal working problem appeared to lie in the fact that the high resistance to the passage of the current required the use of some special device to break down the initial resistance and permit the flow of the current, since this flow can be readily maintained after the initial resistance has been overcome. Experiments along this line have resulted in revealing the great value of the mercury-vapor tube for other purposes than those of illumination. From recent papers in the *Electrical Review* we abstract some discussion of the use of the tube, or bulb, as a rectifier of alternating currents, and also as an interrupter for the production of Hertzian waves for use in space telegraphy.

The use of the device as a rectifier depends upon the fact that the mercury vapor permits the passage of a current in one direction only, and as already described, the negative electrode being in the mercury bulb, and the positive at the other end, the current flows from the upper end of the tube down to the end containing the mercury.

When an alternating current is used instead of a continuous one, only the positive portions of the waves pass, the negative ones being checked, and hence a succession of pulsations are passed. If a polyphase current is employed, it is only necessary to have as many positive electrodes at the upper portion of the bulb as there are phases to the current, with but a single negative electrode below, together with a starting positive electrode in connection with the other positive connections. The result is a succession of positive pulsations, constituting practically a continuous current, derived from the polyphase current by the interposition of a simple piece of apparatus without moving parts. The efficiency of the apparatus is dependent upon the voltage of the current to be transformed, since it appears that the loss in the transformer is about 14 volts at all times, so that with a current of 140 volts the loss would be 10

per cent., and with a current of 1,400 volts, only 1 per cent. The loss appears as heat, the mercury being vaporized and condensed upon the interior surface of the tube.

While it is too soon to be sure of the industrial applications of such a current rectifier, it offers large possibilities, when the size and cost of the present rotary converters are taken into account. In its present form it is adapted for the charging of storage batteries, and there is little doubt that it will be rendered available for other and more extensive applications.

The use of the mercury tube as an interrupter also follows as a consequence of the initial resistance of the mercury vapor to the passage of the current, and includes the fact that when the resistance has been overcome, it will reappear again when the potential is allowed to fall. For this purpose the mercury tube is arranged in connection with condensers in such a manner as to produce a succession of discharges across the tube, the latter forming an interrupter of low resistance and ready controllability.

With all the improvements which have recently been made in the receiving apparatus of space telegraphy there has been little or nothing done to advance the method of producing the impulses at the transmitting end.

This is in marked contrast to the development which has been seen in the receiving apparatus, the coherer of Branly and Lodge having been followed by the mercury drop of Solari and by the magnetic detection of Marconi, each rendering the reception of the message more certain and rapid than was possible with its predecessor, so that until now the transmitting apparatus has remained unimproved.

"The method now employed to set up oscillations in the sending circuit of a wireless telegraph station consists of a discharge of condensers across an air-gap; but this method gives rise to oscillatory discharges of such a character that it is practically impossible to tune a receiver to them, and since the resistance of the spark-gap is high, the power which may in this way be radiated is comparatively small. The Cooper Hewitt mercury vapor interrupter, however, gives continuous impulses of equal amplitude. The frequency of these will be predetermined precisely by the constants of the circuit, so that selective telegraphy will not only be possible, but easy. That is to say, there will be no difficulty in tuning a receiving circuit to respond to a given frequency."

Experiments which have been made with the mercury-vapor interrupter show that it is eminently adapted to be used as a transmitter for space telegraphy, and a comparison with a spark-gap interrupter demonstrated the great increase in discharge which the new interrupter made possible.

"Many attempts have been made to produce an effective high-speed interrupter which would have a reasonable life. Up to this time the discharge-gap between polished metal spheres has been most satisfactory, but it is far from perfect. In the first place, a spark-gap operating in air is too slow, owing to its resistance and to the character of the discharge across it. The effectiveness of the spark-gap in air is increased by using large metal spheres having polished surfaces, but the surfaces of these are rapidly destroyed by the current. That they are inefficient is proved by the rapidity with which they become heated if the discharge is of any considerable magnitude. The Cooper-Hewitt mercury vapor interrupter, on the other hand, seems to be free from all these defects. When a certain difference of potential between the terminals of the interrupter has been reached, the initial negative electrode resistance practically disappears, and the rapidity with which the discharge can take place depends only upon the capacity and the inductance of the circuit. In other words, the condenser charges and discharges at a definite frequency, determined by the circuit, and the source of supply. Discharges that will re-enforce the oscillations before their decay are far more effective in producing the desired electrical effects in a suitable circuit than the irregular discharges of an ordinary spark-gap."

The mercury-vapor tube, therefore, appears to have developed three distinct functions, all of them important, and yet each relating to a different department of electrical work, including lighting, transformation, and wave transmission. Which of these may develop into the most important, time will tell, but it is not often that such a simple device proves capable of producing such far-reaching effects.

THE STEAM TURBINE.

A STUDY OF THE PROBABLE DEVELOPMENT OF THE STEAM ENGINE IN THE LIGHT OF EXPERIENCE WITH THE STEAM TURBINE.

Professor Stodola—Verein Deutscher Ingenieure.

AMONG the subjects discussed at the Düsseldorf meeting of the Verein Deutscher Ingenieure there was presented a paper upon the steam turbine by Professor Stodola which treated of the subject in a thoroughly scientific manner. This paper has since ben expanded by the author into an exhaustive treatise upon the whole subject of the use of steam in turbo-motors, examining the thermodynamics of the subject, and discussing the probable effect of the introduction of such machines upon the future of steam engine design, the whole appearing as a serial in the pages of the *Zeitscrift des Vereines Deutscher Ingenieure.* It is possible here to give only a brief abstract of this important contribution to the literature of steam engineering, but a general idea of the treatment may be given as indicating the scope of the subject.

Remarking, in the first place, upon the fact that the idea of using the impact of a jet of steam to drive a revolving wheel is a very old one, Professor Stodola calls attention to the fact that such machines have become possible in a practical sense only with the improvements in machine construction, enabling the accurate fitting and high rotative speeds to be dealt with successfully. In addition to this general condition there have been other good reasons why the development of the steam turbine has been delayed until the present time, such as a lack of knowledge of the action of steam jets, together with a tardy appreciation of the methods of balancing, and the prevention of excessive vibration.

Professor Stodola takes up the problems to be dealt with in order, discussing the thermodynamics of steam jets, the mechanical question of high-speed construction, and the prevention of vibration, in the order named, concluding with an account of existing machines, with suggestions for future designs.

In considering the conversion of heat into mechanical energy by the use of jets of steam it is necessary to examine into the possible sources of loss, these being found mainly in the frictional resistance to the flow and the losses in eddying, and by assuming an adiabatic flow, in which heat is neither supplied or lost it is possible to show the development of mechanical energy from heat in the form of a temperature-entropy diagram directly by measuring the fall of temperature with the performance of work. A general form of diagram, adapted especially for the study of the flow of steam under the conditions existing in steam turbines is given, based on the method of Professor Mollier, and by its use the thermodynamics of steam jets may be examined in a very satisfactory manner.

The mechanical action of such jets, including the phenomena of impact require examination, and an important portion of Professor Stodola's paper is devoted to this portion of the subject the pressures developed upon the buckets of the turbine being shown graphically, and the relation to the form of buckets discussed. An ingenious apparatus for the measurement of the pressure upon stationary buckets of various forms was devised for use in these researches, the data thus being derived originally for this discussion.

In regard to the mechanical construction of the revolving member of a turbine the question of resistance to the centrifugal force becomes an important element at the high rotative speeds necessary to obtain the highest mechanical efficiency. For wheels of the De Laval type the section of the disc is made that of a body of uniform strength, and a comparison between this and a disc of uniform thickness shows the gain in strength obtained by the scientific distribution of material.

The question of balancing and the prevention of vibrations is examined mathematically, and the effect of the departure, even in the smallest degree, of the centre of gravity from the axis of rotation is fully shown. Since it is practically impossible to secure perfect balance, the importance of the flexible shaft, as used by De Laval, appears, this enabling the disc to place itself

in the axis of rotation without producing severe stresses in the shaft or its bearings. The subject of the critical speed is developed mathematically, and the entire problem of dealing with satisfactory mechanical construction at extremely high speeds is examined very thoroughly.

Passing from the theory to the practical work which has been already done, Professor Stodola examines the different machines, classifying them according as the expansion of the steam is conducted in one or several stages. In this portion of the paper some practical methods are given for determining the angles of the buckets, and proportioning the various parts of a machine according to the variable elements which can be controlled. The advantages of the disc turbine of the De Laval type for single expansion are shown, and the effective manner in which the axial turbine of the Parsons type is adapted for multiple expansion appears. An interesting machine is the Zoelly turbine, in which a number of discs, modified from the De Laval form, are used to obtain successive expansions, this form enabling a high efficiency to be secured without the extremely high rotative speed required for the De Laval machine in its simple form.

The paper contains data and results of a number of tests of turbines in Europe and America, steam consumptions as low as 14 pounds per brake horse power being obtained at Elberfeld with a Parsons turbine, a result which is as good as could be expected from a reciprocating engine under similar conditions.

So far as the commercial development of the steam turbine is concerned, Professor Stodola calls attention to the fact that in Europe already there has been built about 90,000 horse power of the De Laval turbine, and about half as much power of Parsons's type. The firm of Brown, Boveri & Co., in Switzerland, has constructed 16,000 horse power, while in America the Westinghouse Company has constructed 40,000 horse power of Parsons turbines. The Rateau turbine is already being manufactured on a commercial scale, and numerous other designs are being prepared and developed. Already units as high as 5,000 horse power have been successfully constructed, and there is every evidence that the mechanical and commercial difficulties have been practically surmounted. The influence of this activity upon the general course of steam engine design may well be a subject for serious consideration. The advantages of high speed have already been appreciated, even with the difficulties which high speeds involve with reciprocating engines, but with all the reciprocating movements abandoned, and with direct-connected electrical generators, including electrical distribution and regulation, there is every reason to expect a transformation in steam power plants which will render what are now considered the finest examples of steam engineering, candidates for the scrap heap and the museum.

THE TAYLOR-WHITE TOOL STEEL.

PROCESSES OF TREATING TOOL STEELS TO OBTAIN MAXIMUM EFFICIENCY AT HIGH CUTTING SPEEDS.

Report of the Franklin Institute.

ALTHOUGH modern high-speed tool steels have been extensively discussed in the technical press for the past two years, the information about them has lacked that definiteness which is desirable upon such an important subject. In Germany the Society of German Engineers has made some investigations, and papers have been read before technical societies, but now we have the report of the sub-committee of the Franklin Institute, appointed to examine and report upon the Taylor-White steel with a view of its eligibility for award of some one of the honors in the control of the Institute, and from this report published in the *Journal* of the Institute, we make some abstracts. When it is understood that the sub-committee included among its members such well-known engineers as Dr. Coleman Sellers, Mr. James Christie, and Mr. Wilfred Lewis, the nature and character of the investigation will be seen.

The improvements in modern tool steels may be said to have originated in an inves-

tigation of such steels undertaken about three years ago at the works of the Bethlehem Steel Company. At that time the only steels under consideration were the usual carbon tool steel, and the air or self-hardening steel of Mushet. The Mushet steel had almost entirely replaced the carbon steel for roughing purposes, its efficiency being about 50 per cent. higher than carbon steel when used to the best advantage. This was due to the fact that Mushet discovered by reason of the addition of manganese and tungsten to tool-steel that is was possible to maintain a cutting edge at a much higher temperature than otherwise, this permitting the employment of higher cutting speeds. At the same time the results obtained with Mushet steel varied greatly at different times, and hence the experiments referred to above were undertaken to determine, if possible, the influence of variations in the process of hardening upon the product.

Up to the time of these investigations it was the practice to harden all air-hardening steels by heating to a cherry-red and either allowing to cool gradually or in a blast of air. Users were invariably cautioned against overheating, cherry-red being specified indicating as the correct temperature.

The tests undertaken to investigate the effect of various hardening temperatures consisted in the forging of a number of tools of a certain brand of steel and heating them to different temperatures, these tools then being tested in a special lathe arranged for heavy work provided with means for a gradual regulation of speeds throughout a wide range. The results revealed the remarkable fact that while it is true that tools made of air-hardening steels all deteriorate at temperatures in excess of a bright cherry, it is also true that when air-hardening steels are made with certain constituents in ascertained proportions this deterioration prevails only during a limited range of temperatures above the bright cherry red; that is, from about 1,550°F. to about 1,700°F., while above this latter temperature to about 2,000°F. the efficiency of such steels is greatly increased. The special constituents in ascertained proportions to which reference has been made are about one-half of 1 per cent. of chromium and at least 1 per cent. of tungsten or molybdenum, there being various modifications of these proportions described in the Taylor-White patents. The elements affecting the steel appear to be all members of the chromium group, tungsten and molybdenum being those commercially available. The percentage of carbon appears to have little or no effect on the results, steels containing from 85°C. to 200°C. having the same efficiency.

In connection with the use of these higher hardening temperatures the method of cooling is modified, the tool being cooled rapidly from the high heat to a point below the breaking-down temperature, about 1,700°F., in a lead bath, then slowly in air or lime.

It is essential that at no time should the temperature rise, as in such case the tool would be seriously impaired. The importance of the heating and cooling operations has led Messrs. Taylor and White to devise apparatus for attaining the proper temperatures very closely, this conducing to the uniformity of the product.

The report of the committee includes experiments made by them upon a large number of other tool steels in the market at the time of the original production of the Taylor-White steel, the results of these tests being tabulated in the report. These tests were made upon hammered forgings of steel, upon soft steel forgings, and upon cast iron. The results showed that the relative efficiency of the treated tool and the best untreated tool was 11 to 3, or more than 3.5 to 1 for the hard forging, while for the soft forging it was 156 to 70, or 2.2 to 1, and for cast iron 70 to 55, or about 1.3 to 1.

This shows that for steel the efficiency is much greater for hard forgings than for soft, but even in the latter case it exceeds two to one, while, as might be expected, the saving on cast iron is much less, being about 1¼ to 1.

The great peculiarity about the steel, as is well known, is its ability to maintain the cutting edge uninjured even when operated at a red heat. Thus a tool cutting with a red heat maintained 5/16 from the point for a period of twenty minutes, was afterwards examined with a magnifying glass and the original grinding marks were still visible.

The report emphasises the fact that such a steel is valuable only for roughing purposes, and unless used at sufficient speeds to remove large quantities of material no

gain need be expected from its use. Thus attempts have been made to use such steels for finishing cuts on light work with the natural result that there was not sufficient mass of metal in the work to carry away the heat, and the *work*, not the tool, failed under the test. For such purposes there is no advantage in using the high-speed steel, and tests made under such conditions are necessarily misleading.

Having such a high-speed steel the question as to its real value in machine shop processes remains to be considered, although this feature was but touched upon on the committee's report. This is a matter of shop practice altogether. To put on large quantities of metal for the sake of using extraordinarily powerful tools and improved steels for the fun of cutting it off again may seem to be rather doubtful policy, but it must be remembered that there is a large gain at the other end of the line, namely, in the making of the forging. To forge closely to size, especially in heavy work, is a slow and expensive operation. In modern work every saving in time is understood to count for economy in a double sense, saving both the labor cost of the productive workmen, and cutting down the proportion of establishment charges to be borne by the work. In view of such fields for economy the cost of the material is insignificant, especially as the material is not wholly lost, but goes again to the furnace to reappear in succeeding work. The advantages of saving in time was long ago realized in the introduction of the bolt-cutting machine, in which it was demonstrated to be far more economical to cut the round body of the bolt down from hexagon bars of the size of the bolt head than to forge hexagon heads on to round iron.

The high-speed steel applies this principle to general work, on a far larger scale, saving the expensive work at the forge on the heaviest work to shape the finished piece at a vastly increased speed in the machine shop. The increased capacity of the shop also counts heavily in the economy in capital account, since extensions and increase in buildings and plant are avoided by the increase in the productive capacity of existing installations.

The influence of the new steels upon machine tool design forms another important element in the question, but this will be found ably treated by Mr. Oberlin Smith in another place in this issue.

THE ACTION OF PUMPS.

EXPERIMENTS UPON THE BEHAVIOUR OF WATER IN PASSING THROUGH PUMPING MACHINERY —MOMENTUM AND INERTIA EFFECTS.

Institution of Mechanical Engineers.

AT a recent meeting of the Institution of Mechanical Engineers there was presented a paper by Professor John Goodman, giving data and results of certain tests made by him upon a plunger pump, with an interesting discussion upon the phenomena observed, and some abstract of the discussion is here given.

As Professor Goodman well remarks, the action of a pump is by no means the simple thing which it appears upon inspection, forces and actions being set up which require explanation and regulation.

In order to study the behaviour of the water in the course of its passage through the various parts of a pump, Professor Goodman undertook in the engineering laboratory of Yorkshire College, Leeds, a series of experiments upon a plunger pump of moderate size, equipped with various devices to enable the various actions to be observed and recorded. The pump was arranged to be driven either by its own steam cylinder or by a belt, a speed indicator showing the velocity, the water delivered was measured over a V weir, and indicators were placed on the pump barrel steam cylinder, delivery pipe and suction pipe so as to enable the actual pressures to be recorded at all these points simultaneously. The suction pipe was connected so that its length could be made either 36 or 63 feet, while various changes could be made in the water valves and air chamber.

The experiments were conducted for the purpose of finding out how the slip, or discharge coefficient, as well as the water hammer on the suction pipe, were affected by

variations in delivery pressure, changes in speed, alterations in length of suction pipe, and removal of suction valve. The tests were also intended to show the behaviour of the valves, the speed at which cavitation, or separation of the suction column occurs, and the general conditions affecting the efficiency of the pump considered as a machine. The details of the experiments are described in the paper, together with reproductions of indicator diagrams, showing the manner in which the pressures were recorded, and the whole investigation appears to have been conducted in a manner which should inspire confidence in the results and conclusions.

Considering the slip of a pump it is usual to consider that the volume of water pumped is from 95 to 100 per cent. of the plunger displacement, the loss being due to leakage and the presence of small quantities of air. In a few isolated instances a negative slip has been observed,the delivery being greater than the plunger displacement, and Professor Goodman's experiments show the conditions under which this action occurs, and indicate the manner by which it may be computed.

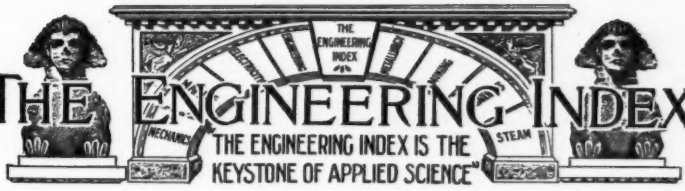
For moderate speeds, the experiments showed that the delivery was about 94 per cent. of the plunger displacement, a result quite in accordance with experience elsewhere, but at higher speeds pounding and hammer blow occurred, the hydraulic-ram action of the water in the suction pipe carrying it past the suction and discharge valves and increasing the delivery to amounts of more than 50 per cent. in excess of the plunger displacement. Of course the actual amount of work performed in no case exceeded the indicated work done in the pump barrel, the increased friction, in fact, making it less than when there was no such negative slip. The indicated horse power in the steam cylinder and the power calculated from the pressure in the pump barrel and the quantity of water passing over the weir agreed very closely in all cases, so that the negative slip was in all instances an injurious effect.

The indicator diagrams taken from the pump valves show that their action, when uncontrolled, is by no means so simple as has sometimes been supposed, and that their movements are correct only on low speeds and when delivering against a moderate head. The velocity of water through such valves should not exceed about two feet per second. The banging which is often heard in the suction pipes of pumps is shown to be due to the separation of the plunger from the water and their subsequent meeting. This action can be prevented by the use of a suitable air chamber on the suction pipe close to the pump, by reducing the velocity of the water, or by using a shorter suction pipe.

When such modifications cannot be made the proper remedy is that pointed out by Professor Riedler as a result of his extensive researches on pumping machinery; namely the use of mechanically operated valves. Such valves have the double advantage that their opening and closing can be positively determined and modified, and that high lifts and large openings may be given without involving heavy blows of the valves upon their seats. The added complication of the valve gear may be offset by the fact that single large valves may be used where otherwise several smaller ones would have become necessary.

The great convenience of using electric driving for pumping machinery is becoming generally appreciated, especially for mining work and for other locations in which the transmission of power by steam or compressed air is unsatisfactory. For such driving, however, the high speed of the motors requires the introduction of high-speed pumps, otherwise reduction gearing or similar devices must be employed. These considerations, together with the small size and light weight of high-speed pumps render it especially desirable that their action under such working conditions be thoroughly understood, and that the causes of defective action and noisy working at high speeds be eliminated.

Professor Goodman's paper is an excellent example of the manner in which useful research work may be performed in a college laboratory, affording instruction in methods of investigation and at the same time rendering permanent services to the practical work of machine construction.



The following pages form a DESCRIPTIVE index to the important articles of permanent value published currently in about two hundred of the leading engineering journals of the world,—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every article.

(1) The full title,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
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(6) When published.

We supply the articles themselves, if desired.

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer and works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of any article referred to in the Index, together with all illustrations, can be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the journals indexed are given.

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A Concrete-Steel Culvert for Stream Diversion at Kalamazoo, Mich. George S. Pierson. A statement of the conditions and an illustrated description of the work. 2100 w. Eng News—Feb. 12, 1903. No. 53543.

Drawbridge.

Wood Block Paving and Other Features in Connection with a Small Drawbridge in Brooklyn, N. Y. Illustrated description of a bridge for heavy traffic. 1000 w. Eng Rec—Feb. 7, 1903. No. 53503.

We supply copies of these articles. See page 157.

Foot-Bridge.

Monier Footbridge Over the Coblenz-Treves Railway (Fussweg Uberfuhrung in Monier Konstruktion auf der Linie Koblenz-Trier). Illustrated description of a light and effective arch bridge in reinforced concrete on the Monier system. 1000 w. Deutsche Bauzeitung—Jan. 14, 1903. No. 53750 B.

New York.

The Manhattan Bridge, New York. Illustrates some of the main features of Bridge No. 3, which will connect Canal St., New York, with Fulton St., Brooklyn, with description. 1200 w. Eng Rec—Feb. 21, 1903. No. 53837.

Quebec.

The Substructure for the 1800-ft. Cantilever Bridge at Quebec, Canada. Illustrated description of the substructure and foundations of the longest span bridge in the world, now in process of construction across the St. Lawrence River. 6000 w. Eng News—Jan. 29, 1903. No. 53309.

Viaduct.

The Approach to the Pennsylvania Railroad Bridge at Fifty-second Street, Philadelphia. Detailed description of bridge and approaches of this important improvement. Ill. 2400 w. Eng Rec—Feb. 14, 1903. No. 53636.

CANALS, RIVERS & HARBORS.

Dredging.

Bucket, Suction, and Pressure Dredge (Selbstadener Ernier Druck und Sangbagger). A description of the new dredge built by Conrad, of Haarlem, Holland, for the Russian government for the harbor of Riga. 1000 w. Glasens Annalen—Feb. 1, 1903. No. 53732 D.

Modern Machinery for Excavating and Dredging. A. W. Robinson. The first of two articles discussing the artificial methods of deepening and maintaining channels by dredging, with illustrations of modern powerful dredges and excavators. 4000 w. Engineering Magazine—March, 1903. No. 53792 B.

Plant and Methods Employed in Excavating Ambrose Channel, New York Harbor. Describes the dredges, and manner of operation, with general comments. 2500 w. Eng News—Feb. 12, 1903. No. 53542.

Embankment.

Quay Wall Construction at Rotterdam (Kadebouw te Rotterdam). R. A. Van Sandick. A very complete account of the harbor improvements at Rotterdam, with numerous illustrations showing the difficult character of the work. 10,000 w. De Ingenieur—Jan. 24, 1903. No. 53739 D.

Gauging.

See Civil Engineering, Measurement.

Isthmian Canal.

An Alternative Line for the Nicaragua Canal; and a Proposed New Method of Dam Construction. J. Francis Le Baron. A reply to the discussion of the writer's paper on this subject. 3500 w. Pro Am Soc of Civ Engrs—Jan., 1903. No. 53354 E.

The Panama Canal. George S. Morison. An illustrated article discussing the principal features of the canal, describing both plans and giving comparative estimates. 11000 w. Pro Am Soc of Civ Engrs—Jan., 1903. No. 53350 E.

The Panama Canal. John George Leigh. This first of a series of articles gives an interesting historical review of this project, with maps, sections and illustrations. 1300 w. Trac & Trans—Feb., 1903. Serial. 1st part. No. 53622 E.

Nile.

Completion of the Nile Dams. John Ward. An illustrated article describing interesting features of these recently completed reservoirs, with information in regard to the region. 2000 w. Cassier's Mag—Feb., 1903. No. 53829 B.

The Nile Reservoir. Some particulars relating to the construction of this great engineering work and the effect it will have on the country. 700 w. U S Cons Repts, No. 1568—Feb. 11, 1903. No. 53-487 D.

The Temple of Philae. An account of the examination of the foundations to make sure that the stability of the structures would not be endangered by submerging the island. Ill. 1800 w. Engng—Jan. 23. 1903. No. 53456 A.

Stream Flow.

The Stream-Flow Laboratory of the Carlsruhe Polytechnic (Le Laboratoire d'Hydraulique Fluvide de l'Institut Tecnique de Carlsruhe). A description of the testing tank for the study of the action of stream flow upon the beds and banks of rivers. 2000 w. 1 plate. Génie Civil—Jan. 24, 1903. No. 53715 D.

Teltow.

The Teltow Canal (Der Teltow Kanal). Chr. Havestadt. A description of the waterway connecting the upper Spree with the Havel. With map, profile, and sections of the channel. Serial, Part I. 1500 w. Deutsche Bauzeitung—Feb. 7, 1903. No. 53751 B.

CONSTRUCTION.

Fireproofing.

Simple Ways of Fireproofing. Russell Sturgis. An illustrated article outlining the method of building of actually fire-

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proof buildings. 3700 w. Arch Rec—Feb., 1903. No. 53565 C.

See also Civil Engineering, Materials.

Foundations.

Experience with Foundations in Boston. Abstract of a paper by J. R. Worcester, read before the Boston Soc. of Civ. Engrs. Outlines the geologic formation and discusses principally the pile foundations and their problems. 1600 w. Eng News—Feb. 5, 1903. No. 53416.

Sub-Structure at the New Schlesinger & Mayer Store Building, Chicago. Illustrates and describes the construction of foundations under peculiar and unusual conditions. 3200 w. Eng Rec—Feb. 21, 1903. No. 53836.

Hotel Construction.

Hotel Belmont. Illustrated description of the difficult engineering features of a hotel under construction in New York City, at the corner of 42d St. and Park Ave., 26 stories high, with 5 below the surface. The conditions and requirements are in many respects unusual. The Rapid Transit Ry. passes under one corner. 5700 w. Eng Rec—Feb. 7, 1903. No. 53502.

Masonry.

Notes on Cement Masonry. I. N. Knapp. Written for the annual meeting of the Am. Gas Lgt. Assn. Facts of interest from the writer's experience in concrete construction, with much valuable information. Also discussion. 10000 w. Stevens Ind—Jan., 1903. No. 53659 D.

Mill Construction.

Slow-Burning or Mill Construction. Edward Atkinson. Extracts from report No. V., of Insurance Engineering Experiment Station, Boston. 4000 w. Ins Engng—Jan., 1903. No. 53348 C.

Mosaic.

Methods of Mosaic Construction. W. L. H. Hamilton. An illustrated article on the revival of mosaic as an architectural adjunct, describing the old and new methods of construction. Discussion. 9300 w. Jour Soc of Arts—Feb. 6, 1903. No. 53588 A.

Pillars.

The Construction of the Deflection Line of Straight Pillars, and their Applications in Statics (Die Konstruktion des Biegungslinie Gerader Stäbe und ihre Anwendung in der Statik). L. Vianello. A graphical treatment of flexure in struts and pillars, with practical applications. 2500 w. Zeitschr d Ver Deutschr Ing—Jan. 17, 1903. No. 53705 D.

Tunnels.

Tunnel Construction Under Water. Howard A. Carson. Abstract of informal remarks before the Boston Soc. of Civ. Engrs., with illustrations, describing the construction of the East Boston tunnel. Discussion. 6300 w. Jour Assn of Engng Socs—Dec., 1902. No. 53663 C.

MATERIALS.

Cements.

Plasters and Hard Finishing Cements in the United States. Edwin C. Eckel. Gives the divisions of the "Hydrate Cements," and some notes on Keene's cement. 900 w. Eng News—Jan. 29, 1903. No. 53312.

Progress Report of Special Committee on Uniform Tests of Cement. An important article on cement testing practice, giving the results of investigations and conclusions of a special committee appointed to determine a uniform method. Ill. 4000 w. Pro Am Soc of Civ Engrs—Jan., 1903. No. 53349 E.

The Artificial Portland Cement of Haiphong (Ciments Portland Artificiels de Haiphong). F. Schiff. A description of the cement works at Haiphong, China, and their products. 2000 w. Génie Civil—Jan. 24, 1903. No. 53714 D.

The Cement Industry and Its Prospects for 1903. Discusses the production and use, the prospect of over production, the domestic and imported products, etc. 2500 w. Munic Engng—Feb., 1903. No. 53359 C.

Concrete.

The Maximum Permissible Compression Stresses upon Concrete (Die Zulässigkeit Hoher Druckspannungen im Beton). Fritz v. Emperger. With diagrams showing the elastic limit of concrete as compared with other materials of construction. 3000 w. Beton & Eisen—1 Heft, 1903. No. 53784 F + H.

Plaster of Paris.

Tests for Plaster of Paris. Explains the composition and attending chemical and physical facts, showing a method of testing based on scientific data, and giving results of trials made by the writer. 1500 w. Stone—Feb., 1903. No. 53300 C.

Reinforced Concrete.

A Neglected Point in the Theory of Concrete Steel. John Stephen Sewell. A study of the stresses that give trouble in this material, and their causes and remedies. Ill. 1800 w. Eng News—Jan. 29, 1903. No. 53314.

Bridge in Reinforced Concrete over the Rio Caudal at Mières, Spain (Pont en Béton Armé sur le Rio Caudal à Mières, Espagne). Giving the details of computations of a reinforced concrete arch of 35 metres span by M. J. Eugenio Ribera. 3000 w. Beton & Eisen—1 Heft, 1903. No. 53782 F + H.

We supply copies of these articles. See page 157.

Comparative Tests upon Reinforced Concrete Beams (Vergleichende Proben mit Verbund Balken). L. A. Sanders. Data and results of exhaustive tests upon T beams in the direct and inverted positions; with numerous illustrations. 3000 w. Beton & Eisen—1 Heft 1003. No. 53-785 F + H.

Computing the Strength of Concrete Steel Beams. Edwin Thacher. Refers to a recent paper by Prof. W. K. Hatt and the tests reported, and gives an account of the writer's investigations with formulas. 3500 w. Eng News—Feb. 12, 1903. No. 53540.

Hennebique Fireproof Construction in New York and Cleveland. Gives particulars of this system, comparing it with the Ransome, and describing its use in buildings in the cities named. 2000 w. Eng Rec—Jan. 31, 1903. No. 53443.

Rupture Tests upon Hennebique Floors of the "Palais de Costume" (Bruchversuche mit Zwei Deckplatten System Hennebique, in "Palais de Costume.") M. Rabut. Giving details of the tests of reinforced-concrete floors made during the removal of certain buildings of the Paris exposition of 1900. 4000 w. Beton & Eisen—1 Heft, 1903. No. 53783 F + H.

The Initial Stresses in Reinforced Concrete Beams (Die Anfangsspannungen in Beton-Eisenträgern). Karl Haberkalt. An analytical examination of the manner in which imbedded rods of iron act to reinforce beams of concrete against deflection. 4000 w. Zeitschr d Oesterr Ing u Arch Ver—Jan. 30, 1903. No. 53723 B.

See also Civil Engineering, Bridges.

See also Civil Engineering, Construction.

MEASUREMENT.

Gauging.

An Electrical River Gauge. J. F. Barnes. Illustration, with description of the construction and action of an automatic recording apparatus developed by Weston M. Fulton. 1000 w. Elec Rev, N. Y.—Feb. 14, 1903. No. 53582.

Current Meter Ratings and Observations by the U. S. Irrigation Investigations Department. Describes the method employed in rating current meters and computing the results obtained, with a description also of field methods. 2300 w. Eng News—Feb. 12, 1903. No. 53541.

Road Testing.

Testing Road Surfaces by the Viagraph. Thomas Aitken. Read before the Scottish Assn. of Munic. Engrs. & Survs. Gives a report of tests carried out in London, and various cities of Scotland, showing autographic records of the irregularities of road surfaces taken by this instrument. 3800 w. Quarry—Feb. 1, 1903. No. 53604 A.

Surveying.

The New Line of the Rhaetikon Railway (Die Neuen Linien der Rhätischen Bahn). W. Graf. A full description of the surveying work in the alignment of the tunnels on the railway between Thusis and St. Moritz, Switzerland, including the Albula tunnel. 2000 w. Schweiz Bauzeitung—Dec. 27, 1902. No. 53753 B.

Water Measurement.

See Civil Engineering, Water Supply.

Water Waste.

See Civil Eingineering, Water Supply.

MUNICIPAL.

Municipal Trading.

See Industrial Economy.

Pavements.

Bituminous Macadam Pavement. C. A. Kenyon. Describes this pavement, and considers it has the good qualities of macadam, and the best qualities of asphalt pavement. 3000 w. Munic Jour & Engr—Feb., 1903. No. 53395 C.

Practice in Laying Brick Pavements. Calls attention to the care needed for the foundation, the choice of filler and its application, etc. Ill. 2200 w. Munic Jour & Engr—Feb., 1903. No. 53393 C.

Warren's Bituminous Macadam Pavement. C. A. Kenyon. Abstract of paper before the Indiana Engng Soc. Discusses the virtues and defects of macadam roads, and the improvement introduced by Frederick J. Warren. 2200 w. Munic Engng—Feb., 1903. No. 53361 C.

See also Civil Engineering, Bridges.

Refuse.

The "Fuel" Value of Town Refuse:—A Rejoinder. Frank Broadbent. A reply to an article by E. C. de Segundo, in the December issue of *Page's Magazine*. 2500 w. Elec Rev, Lond—Jan. 23, 1903. No. 53469 A.

The Fuel Value of Refuse. W. H. Booth. Discusses its value as a heat producer, and its use by electric stations. 1500 w. Elec Rev, Lond—Feb. 6, 1903. No. 53610 A.

The Sanitary Disposal of Municipal Refuse. An informal discussion of the disposal of ashes, street sweepings, dry rubbish and garbage. 13800 w. Pro Am Soc of Civ Engrs—Jan., 1903. No. 53352 E.

Septic Tank.

The Septic Tank at La Grange, Ill. William B. Ewing. Briefly describes this system of sewerage, and gives an account of the developments following the beginning of use of the tank. Ill. 1300 w. Eng Rec—Feb. 21, 1903. No. 53838.

Sewage.

The Discharge of Sewage into Dublin Harbor, Ireland. Extracts from a paper by William K. Parry and Walter E. Adeney before the Inst. of Civ. Engrs. Gives investigations made and conclusions drawn, and abstract of discussion criticizing the conclusions. 3200 w. Eng Rec—Feb. 14, 1903. No. 53638.

WATER SUPPLY.

Artesian Well.

A Peculiar Artesian Well in the Klondike. J. B. Tyrrell. Gives a brief statement of the topography and structure of the region, and explains the conditions under which the flow was encountered. Ill. 900 w. Eng & Min Jour—Jan. 31, 1903. No. 53441.

City Supply.

Concerning an Ideal Water Supply. George W. Fuller. Read before the Minnesota State San. Assn. Considers some of the aspects of public supplies and means taken to secure purity. 4800 w. Munic Jour & Engr—Feb., 1903. No. 53394 C.

Clarifying Plant.

Clarifying Plant for Waste and Drainage Waters. Translated from *Glückauf*. Illustrated description of plant in which the solid impurities are removed by mechanical means at a minimum expenditure of labor. 300 w. Col Guard—Feb. 13, 1903. No. 53693 A.

Electric Pumping.

See Electrical Engineering, Power Applications.

Fire Service.

Fire Mains. John C. Trautwine, Jr. Reviews briefly systems recently introduced in the cities of Cleveland, Milwaukee, Detroit, Buffalo, Providence, Boston, and Chicago, and describes the important features of the system introduced in Philadelphia. Ill. and tabulated results of experiments. Discussion. 14500 w. Pro Engrs' Club of Phila—Jan., 1903. No. 53671 D.

Philadelphia High-Pressure Fire Service. John E. Codman. Illustrated detailed description. Also discussion. 7500 w. Pro Engrs' Club of Phila—Jan., 1903. No. 53672 D.

Pumping Engines.

See Mechanical Engineering, Steam Engineering.

Reservoirs.

Notes on the Arrangement of Reservoirs (Erfahrungen bei Anordnung von Wasser leitungs-Reservoiren). Heinrich Adolf. A discussion of the advantages and disadvantages of various locations for reservoirs, with respect to the distribution system. 2000 w. Zeitschr d Oesterr Ing u Arch Ver—Jan. 30, 1903. No. 53724 B.

Steam Pollution.

A Sanitary Survey of Mill Creek Valley, at and near Cincinnati, Ohio. Describes the conditions of this stream which is said to be probably the foulest in the state, and the efforts under way to remedy the nuisance. 700 w. Eng News—Feb. 12, 1903. No. 53539.

Report of the Passaic Valley District Sewerage and Drainage Commissioners. Items of interest from the report of Rudolph Hering in regard to the purification of this much abused river in New Jersey. 1800 w. Eng Rec—Feb. 14, 1903. No. 53637.

Royal Commission Studies on Pollution and Self-Purification of the River Severn. Reviews the second report of the Royal Commission, giving extracts of interest. Map. 3500 w. Eng News—Feb. 19, 1903. No. 53655.

Stream Pollution and Remedial Policy. M. O. Leighton. Abstract of paper read before the Indiana Engng Soc. Considers the limitations which should obtain in all requirements made for the purpose of stopping stream pollution, and ways that a reform may be brought about. 2800 w. Munic Engng—Feb. 1903. No. 53362 C.

Waste.

Investigations of Water Waste in New York City. A statement concerning the work, how the records are made, and some of the results obtained. 2000 w. Eng News—Feb. 5, 1903. No. 53415.

The Cole-Flad Photo-Pitometer and Its Use in Studying Water Consumption and Waste. Illustrates and describes an application of the Pitot tube being used to make a water-waste survey in New York. 1500 w. Eng News—Feb. 5, 1903. No. 53413.

Water Waste Detection in New York City. An illustrated article describing the system used in these investigations. The Cole-Flad pitometer is being used. 3400 w. Eng Rec—Jan. 31, 1903. No. 53442.

Water Waste in New York City. Editorial on the investigations in progress and their important results. 1600 w. Eng Rec—Feb. 7, 1903. No. 53501.

The Standard Water Meter. Illustrated description of a new form of positive water meter being introduced in England. 700 w. Engng—Feb. 6, 1903. No. 53614 A.

Water Works.

Madeley Water Supply. An illustrated description of a plant notable as being the largest pumping plant in England operated by gas engines and producer gas. 1400 w. Engr, Lond—Feb. 6, 1903. No. 53619 A.

ELECTRICAL ENGINEERING

COMMUNICATION.

Cables.

Relays for Submarine Cables (Les Relais pour les Cables Sous-Marins). Devaux-Charbonnel. A discussion of the limitations of submarine telegraphy, and the possibility of using relays. Three articles. 3000 w. Electricien—Jan 24, 31, Feb. 7, 1903. No. 53773 each B.

The Manufacture and Laying of a Submarine Cable. Dr. A. E. Kennelly. Abstract of a lecture delivered before Sibley College. The cable described was the one made for the Mexican Government, connecting the ports of Vera Cruz, Frontera, and Campeche on the Gulf of Mexico. Description, with illustrations. 2300 w. Sib Jour of Mech Engng—Jan., 1903. No. 53662 C.

Pacific Cables.

The Cables Across the Pacific. Thomas Commerford Martin. Remarks and information regarding the British and American Pacific cables. Maps. 1500 w. Rev of Revs—Feb., 1903. No. 53356 C.

The Landing of the Honolulu End of the Pacific Cable. A brief account of the work of laying the cable, and the extent of this great work with illustrations of the ceremonies celebrating the landing at Honolulu. 1100 w. Sci Am—Jan. 31, 1903. No. 53317.

The Laying of the American Trans-Pacific Cable. Alexander G. McAdie. An illustrated account of this important project, with chart of deep-sea soundings of the coasts of California and Mexico, and between California and the Hawaiian Islands. 2500 w. Jour of Elec—Jan., 1903. No. 53626 C.

The New Pacific Cable from San Francisco to Honolulu, Hawaii. William H. Crawford, Jr. Illustrated description of the cable-ship "Silvertown," and its equipment for laying the cable and of the getting of the line ashore at San Francisco, and at Honolulu. 1500 w. Marine Engng—Feb., 1903. No. 53404 C.

Space Telegraphy.

Commercial Wireless Telegraphy. Lawrence Perry. An illustrated article describing the sending and receiving of a message by the Marconi system, with an account of the commercial success, and what has been thus far accomplished. 4200 w. World's Work—March, 1903. No. 53834 C.

Portable Station for Wireless Telegraphy (Fahrbare Stationen für Drahtlose Telegraphie). Arthur Wilke. An illustrated description of the portable Braun apparatus made by Siemens & Halske for use in the German army. 3500 w. Elektrotech Zeitschr—Jan. 15, 1903. No. 53764 B.

The Cooper Hewitt Mercury Vapor Current Interrupter. Illustrates and describes the application of the mercury vapor tube as an interrupter for use in space telegraphy. Also Dr. Michael I. Pupin's estimate of its importance. 2200 w. Elec Rev, N Y—Feb. 21, 1903. No. 53810.

The Present Position of Wireless Telegraphy. Charles Bright. Considers what has been accomplished in this field, the efficiency, difficulties, etc., and points out the great service it can render in the transmission of social, or comparatively unimportant messages, which high rates have kept from the cables. 2800 w. Nineteenth Cent—Feb., 1903. No. 53677 D.

Wireless Telegraphy. A. Frederick Collins. A review of what has been accomplished in this field, the stations established, and the present status of cableless messages. 2800 w. Rev of Revs—Feb., 1903. No. 53355 C.

Wireless Telegraphy by the Fessenden System. A. Frederick Collins. An illustrated description with report of some of the most important results achieved. 2200 w. Elec Rev, N Y—Feb. 21, 1903. No. 53811.

Telephone Cables.

Cable Construction for Telephone Lines. General specifications, with illustrations. 10,000 w. Elec Wld & Engr—Feb. 14, 1903. No. 53584.

Telephone Conduits.

Methods of Work Adopted in Constructing the Chicago Telephone Tunnels. Gives illustrated general description of the work and methods of construction of conduits for placing telephone wires underground. 2000 w. Eng News—Feb. 19, 1903. No. 53654.

Telegraphy.

Recording Telegraph for Amateurs. George M. Hopkins. An illustrated description. 1000 w. Sci Am—Feb. 21, 1903. No. 53823.

DISTRIBUTION.

Conductors.

Methods of Supporting and Protecting Inside Conductors. O. L. Falconar. Read before the Newcastle Local Sec. of the Inst. of Elec Engrs. Illustrated description of some of the methods in general use. 4500 w. Elec Engr, Lond—Jan. 30, 1903. No. 53552 A.

We supply copies of these articles. See page 157.

On Metallic Protection for Conductors. J. Prentice. Considers the metallic tube systems, as usually installed, utterly untrustworthy. 700 w. Elec Rev, Lond—Jan. 23, 1903. No. 53468 A.

Some Remarks Upon the Carrying Capacity, etc., of Copper Conductors. Gives results of experimental tests with short lengths of wire, with remarks. 1400 w. Elec Engr, Lond—Feb. 6, 1903. No. 53607 A.

Great Britain.

Electric-Power Distribution in Great Britain. Describes the work of various companies showing the use of electricity to be developing rapidly. 2500 w. U S Cons Repts, No. 1569—Feb. 12, 1903. No. 53486 D.

Mains.

The Standards for Electricity Supply Mains. Full text of the latest standard terms and conditions as agreed upon by the Cable Makers' Assn., England. 1500 w. Elect'n, Lond—Feb. 13, 1903. No. 53691 A.

Transformer Cores.

The Best Thickness for Transformer Core Plates for Minimising Iron Losses (Die Hinsichtlich der Eisenverluste Günstige Stärke von Transformatorbleche). Hans Kamps. An investigation of the thickness of sheet iron plates for transformer cores to secure a minimum loss from hysteresis and eddy currents. 1800 w. Elektrotech Zeitschr—Feb. 5, 1903. No. 53770 B.

Wiring.

The Wiring of Buildings. Review of a paper by O. L. Falconar, read before the Newcastle Section of the Inst. of Elec. Engrs. 2200 w. Elec Rev, Lond—Jan. 23, 1903. No. 53467 A.

The Use of the Multiple Pole Diagram in Graphical Wiring Computations (Der Mehrpolige Polplan in der Zeichnerischen Leitungsberechnung), G. König. Showing the application of the pole diagram and cord polygon to wiring computations in a manner similar to that used in graphostatics. 2500 w. Elektrotech Zeitschr—Jan. 29, 1903. No. 53768 B.

Three-Wire Direct-Current Wiring. P. C. Percy. Directions for wiring, determining the size of the neutral wire, etc. 1600 w. Am Electn—Feb., 1903. No. 53437.

ELECTRO-CHEMISTRY.

Electric Smelting.

Electric Steel-Smelting at Gysinge (Die Herstellung von Elektrostahl in Gysinge). F. A. Kjellin. Describing an electric furnace without carbon electrodes for smelting steel, in practical operation at Gysinge, Sweden; with data as to its performance. 1500 w. Glückauf—Jan. 24, 1903. No. 53743 B.

Electroplating.

Notes on Physical Characteristics of Electro-deposited Metals. Woolsey McA. Johnson. Discusses the influence of the chemical nature of the solution from the point of view of the electrolytic dissociation theory. 2700 w. Elec Chem Ind—Feb., 1903. No. 53645 C.

The Abuse of Electroplating. H. L. Haas. Briefly notes old methods and the important advances made, with remarks on knowledge still needed. 1100 w. Elec Chem Ind—Feb., 1903. No. 53642 C.

The Alloying of Metals as a Factor in Electroplating. Prof. Louis Kahlenberg. Shows that the alloying power of the electrolytic deposit with the coated metal underneath is a factor determining not only the strength with which the deposit adheres, but the length of time the plated article will wear. 1500 w. Elec Chem Ind—Feb., 1903. No. 53641 C.

The Physical Character of Metal Deposits. Prof. C. F. Burgess and Carl Hambuechen. An illustrated article giving information of value and interest in regard to the deposition of metals. 2500 w. Elec Chem Ind—Feb., 1903. No. 53643 C.

Nickel Refining.

History and Present Development of Electrolytic Nickel Refining. Titus Ulke. Describes the Vivian, Balbach, Cleveland, Hamilton, and Papenburg electrolytic nickel works, and discusses the proposed copper and nickel refinery at Sault Ste. Marie. Ill. 4000 w. Elec Chem Ind—Feb., 1903. No. 53644 C.

Storage Battery.

Ampere-Hour Capacity of the Lead Storage Battery. A. L. Marsh. Deals particularly with lead peroxide, showing the present limitations of the lead storage cell in regard to weight and output. 1500 w. Elec Wld & Engr—Feb. 14, 1903. No. 53586.

Structural Details of the Edison Storage Battery. Illustration and cross-section with brief description. 600 w. Sci Am—Feb. 7, 1903. No. 53480.

The Accumulator as a Problem in Electrochemistry (L'Accumulateur et l'Electrochemie). J. Izart. A consideration of the electrochemical principles on which the action of the accumulator is based with examples of computations. Two articles. 2000 w. Electricien, Jan. 24, Feb. 7, 1903. No. 53774 each B.

ELECTRO-PHYSICS.

Graphics.

The Graphical Treatment of Alternating Current Phenomena (Ueber die Graph-

ische Behandlung von Wechselstromproblemen). Dr. E. Orlich. An elementary demonstration of the application of the vector analysis to the study of alternating currents. 1800 w. Elektrotech Zeitschr—Jan. 22, 1903. No. 53767 B.

Interrupter.

See Electrical Engineering. Communication.

Ionization.

The Ionization of Water Nuclei. C. Barus. An account of experimental investigations on the Lenard effect, referring to the work of J. J. Thompson, and giving the result of the writer's study. Ill. 4200 w. Am Jour of Sci—Feb., 1903. No. 53368 D.

Oscillations.

Apparatus for Experiments upon Rapid Electric Oscillations (Vorführung von Experimenten über Schnelle Elektrische Schwingungen). Dr. Georg Seibt. A lecture before the Elecktrotechnische Verein with experiments upon the wireless transmission and reception of electric waves. 3000 w. Elektrotech Zeitschr—Feb. 5, 1903. No. 53771 B.

Plants.

Electromotive Force in Plants. Amon B. Plowman. Reviews the work in this field by Prof. J. Burden Sanderson, giving his conclusions, and offers hints explanatory of the phenomena on which his conclusions are based. 3000 w. Am Jour of Sci—Feb., 1903. No. 53367 D.

Radioactivity.

Concerning Induced Radioactivity and the Emanations from Radium (Sur la Radioactivite Induite et sur l'Emanation du Radium). P. Curie. A communication to the French Academy, discussing the theories of Rutherford. 1500 w. Comptes Rendus—Jan. 26, 1903. No. 53735 D.

The Magnetic Deviability of Certain Rays Emitted by Radium and Polonium (Sur la Déviabilité et la Nature de Certains Rayons Emis pas le Radium et le Polonium). H. Becquerel. A discussion of experiments confirming those of Rutherford as to the influence of a magnetic field upon Becquerel rays. 1500 w. Comptes Rendus—Jan. 26, 1903. No. 53734 D.

Thermo-Electricity.

Observations on Thermo-Electric Currents (Beobachtungen über Thermoelektrische Ströme). Albrecht Heil. An account of experiments with thermo-elements of various metals, with a discussion of possible improvements. 2500 w. Zeitschr f Elektrochemie—Jan. 29, 1903. No. 53776 D.

Transformer Cores.

See Electrical Engineering. Distribution.

GENERATING STATIONS.

Alternators.

The Calculation of the Electromotive Force of Alternators (Le Calcul de la Force Electromotrice dans les Alternateurs). C. F. Guilbert. A mathematical discussion of the influence of the form of construction upon the electromotive force of alternating generators. 2000 w. Revue Technique—Jan. 25, 1903. No. 53722 D.

Boosters.

The Use of Negative Boosters. Explains the action of these boosters, employed to prevent the potential difference exceeding the allowable maximum. Ill. 1900 w. Tram & Ry Wld—Jan. 15, 1903. No. 53326 B.

Carbon Brushes.

Experiments on the Resistance of Carbon Brushes (Ersais sur la Resistance au Contact des Balais en Charbon). M. Bourguignon. Data and results of exhaustive tests of the contact resistance of carbon brushes for dynamos, with discussion by the Société. 5000 w. Bull Soc Int d Electriciéns—Jan., 1903. No. 53786 H.

Equalizers.

Equalizers for Direct Current Dynamos. Alphonse A. Adler. Describes the methods found most satisfactory for transferring loads from one machine to another. 2300 w. Elec Age—Feb., 1903. No. 53375.

Erection.

The Erection of Large Generators. Louis Elliott. General notes on the setting and assembling of heavy units. 2200 w. Steam Engng—Feb. 10, 1903. Serial, 1st part. No. 53527.

Heating.

The Influence of Surface and Speed upon the Heating of Dynamos (Ueber den Einfluss der Beschaffenheil der Oberfläche von Elektrischen Maschinen und der Tourenzahl auf die Erwärmung). Dr. Wilhelm Schüppel. Experiments with surfaces of various colors upon the radiation of heat from dynamos; also the relation of speed to heating. 3000 w. Elektrotech Zeitschr—Feb. 8, 1903. No. 53780 D.

Hydro-Electric.

The Extension of the Schaffhausen Electric Works (Die Erweiterungs bauten der Elektrizitäts werke in Schaffhausen). Illustrated description of recent additions to the plant, and an account of the electric tramway system of the city. 1800 w. Schweiz Bauzeitung—Dec. 27, 1902. No. 53752 B.

The Hydro-Electric Station of the Jonage Canal (Usine Hydro-Electrique du

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Canal de Jonage). H. Clement. A description of the station by which 14,666 horse power is derived, from the power of the Rhone and delivered electrically to Lyons. 2500 w. 1 plate. Revue Industrielle—Feb. 7, 1903. No. 53799 D.

The New Mill Creek Power Plant of the Edison Electric Co., near Redlands, Cal. E. Duryee. Illustrated detailed description. 1600 w. Eng News—Feb. 5, 1903. No. 53414.

Isolated Plant.

Power Plant of the Ferguson-McKinney Dry Goods Co., St. Louis. William H. Bryan. Illustrates and describes a plant representing present practice, and showing the severe conditions of plants for furnishing light, heat, power, etc., for large buildings. 6000 w. Engr, U S A—Feb. 2, 1903. No. 53418.

Municipal Plant.

Municipal Electric Light and Power Plant at Richmond, Ind. James B. Nelson. Abstract of a paper read at the annual meeting of the Indiana Engng. Soc. Descriptive. 2000 w. Eng News—Jan. 29, 1903. No. 53310.

Niagara.

Remarkable Emergency Work at Fire of the Niagara Falls Power Plant. An illustrated account of the accident due to the plant being struck by lightning, and the rapidity with which the lines were placed in service afterward. 1000 w. Elec, N Y—Feb. 11, 1903. No. 53524.

Railway Station.

Power Plant of the Aurora, Elgin & Chicago Railway. Illustrates and describes a plant for furnishing power for a road 56 miles in length, which has been constructed and equipped for speeds equal, if not greater, than steam roads. 3000 w. Eng Rec—Feb. 7, 1903. No. 53504.

Regulators.

Automatic Voltage Regulators. H. C. Wirt. Abstract of a paper read before the Northwestern Elec. Soc. Remarks on the importance of constant pressure, with description of a regulator invented by A. A. Tyrrell. Ill. 2000 w. Elec Rev, N Y—Feb. 14. 1903. No. 53583.

Shipyard.

The Light and Power Plant of the Vulcan Works at Stettin (Die Versorgung der Werkstätten der Stettiner Maschinenbau—A. G. Vulcan mit Kraft und Licht). A. Böttcher. A general description of the power plant of the great Vulcan shipyards, and of the electrical equipment. Serial. Part I. 2500 w. Zeitschr d Ver Deutscher Ing—Jan. 24, 1903. No. 53706 D.

Sunderland.

The Sunderland Corporation Electricity Works. Gives illustrations and descriptions of some of the equipment, with an account of this municipal enterprise and its growth. 4500 w. Trac & Trans—Feb., 1903. No. 53623 E.

See also Street and Electric Railways.

LIGHTING.

Car Lighting.

See Railway Engineering, Motive Power and Equipment.

Incandescent Lamps.

Methods of reducing the Cost of Lighting with Incandescent Lamps (Methoden zur Herabminderung der Kosten der Beleuchtung mittel Elektrischer Glühlampen). Karl Zipernowsky. With curves, showing the life of lamps under various conditions, and their periods of greatest efficiency. 3000 w. Zeitschr f Elektrotechnik—Feb. 1, 1903. No. 53779 D.

Intermittent Currents.

Suggestions for the Use of Intermittent Currents for Electric Lighting. S. H. Holden. Points out means whereby currents which are constant as to direction but periodic as to intensity may be satisfactorily generated, and some uses to which they may be put. 1700 w. Elec Rev, Lond—Jan. 23, 1903. No. 53470 A.

Mercury Arc.

The Mercury Arc. Charles P. Steinmetz. An account of the writer's investigations discussing the features of the mercury arc, and giving a review of the work of others. Also editorial. 2500 w. Elec Wld & Engr—Feb. 21, 1903. No. 53817.

Rates.

Rates and Methods of Charging. J. W. Shuster. Read at meeting of the Northwestern Elec. Assn. Outlines methods of changing for electric current in use in the United States. 2500 w. Am Gas Lgt Jour—Feb. 9, 1903. No. 53491.

Ship Installations.

Ship Lighting. Frank Broadbent. Explains the unfortunate circumstances that affect the wiring of ships, and discusses the generating plants, governors, steam and exhaust service, dynamos, switchboards and fuseboards, in the present article. 2400 w. Elec Rev, Lond—Feb. 6, 1903. Serial, 1st part. No. 53608 A.

MEASUREMENT.

Bearings.

The Electrical Resistance of Bearings. A. E. Kennelly and C. A. Adams. Gives results of experimental study of this subject. 800 w. Elec Wld & Engr—Feb. 7, 1903. No. 53488.

Galvanometer.

An Electrolytic Galvanometer (Elektrolytisches Galvanometer). Richard Heil-

brun. The circulation of the current in a tube containing the electrolyte acts upon the suspended magnet of a mirror galvanometer. 1800 w. Zeitschr f Elektrochemie —Feb. 5, 1903. No. 53777 D.

Construction of a D'Arsonval Mirror Galvanometer. F. W. Cerny. Illustrated description of a self-adjusting instrument built by the writer. 700 w. Am Electn—Feb., 1903. No. 53435.

Instruments.

Electrical Measuring Instruments. Caryl D. Haskins. Considers instruments used in daily practice for purposes of frequent observation and indication of conditions. Ill. 5400 w. Jour Fr Inst—Feb., 1903. No. 53571 D.

Photometry.

Dr. Fleming's Paper on Photometry. Alexander P. Trotter. A critical review. 2800 w. Elec Times—Feb. 5, 1903. No. 53597 A.

Testing.

The Economic Value of Testing. Prof. George D. Shepardson. Abstract of paper read before the Northwestern Elec. Assn. Urges the buying of accurate instruments and having men competent to use them, in central stations for the manufacture and sale of electrical energy. 4000 w. Elec Wld & Engr—Feb. 9, 1903. No. 53489.

POWER APPLICATIONS.

Air Gap.

An Experimental Study of the Influence of Various Air Gaps in Polyphase Motors (Eine Experimental studie über den Einfluss Verschiedener Grossen des Luftzwischenraumes bei Drehstrommotoren). Dr. Max Breslauer. With diagrams showing the influence of changes in the width of the air gap upon the action of motors. 2000 w. Zeitschr f Elektrotechnik—Jan. 18, 1903. No. 53778 D.

Capstans.

Electric Capstans and Cranes at North Eastern Co.'s Railway Docks. Frank C. Perkins. Illustrates and describes some of the details of the installation at these English docks. 2400 w. Mod Mach—Feb., 1903. No. 53411.

Cotton Mill.

Electric Driving at the Mirecourt Cotton Mills (Commande Electrique des Usines de la Société Cotonnière de Mirecourt). J. A. Montpellier. General description of this important installation, in which 650 h. p. is distributed electrically with an efficiency of 71 per cent. 2000 w. Electricien—Jan. 17, 1903. No. 53772 B.

Department Store.

The Electrical Equipment of the New Macy Store Building. Charles E. Knox. Illustrated description of a recently installed plant, which furnishes electricity for lighting, and for driving motors for parcel conveyors, pneumatic blowers, carpet and sewing machines, ventilating fans, glass-cutting machines, etc. 3000 w. Am Electn—Feb., 1903. No. 53433.

Factory Plant.

Electric Power Transmission at Arbroath. An illustrated account of the plant installed at the Lowson Mills, which operates six factories situated in different parts of the same town. 3000 w. Engng—Feb. 13, 1903. No. 53696 A.

Hoisting.

Improvements in the Application of Electricity to Mine Hoisting Machinery (Neuerungen in der Verwendung der Elektrizität beim Fördermaschinenbetriebe). R. Schmidt. Describing the electric winding plant in operation at the Germania Mine near Marten, in the Dortmund district; the shaft is 450 metres deep. 3500 w. Glückauf—Jan. 31, 1903. No. 53744 B.

Winding Machines with Direct-Connected Motors (Die Fördermaschinensysteme mit Direkt Gekuppelten Motoren). H. Baum. A discussion of the application of electric driving to heavy mine hoisting. Serial, part I. 3000 w. Glückauf—Feb. 7, 1903. No. 53746 B.

Induction Motors.

The Care of Induction Motors in a Large Factory. Arthur B. Weeks. Hints for the inspection and care of these motors. 1200 w. Am Electn—Feb., 1903 No. 53438.

Iron Works.

Alternating vs. Direct-Current, as Applied to the Iron and Steel Industry. C. H. Hines. Arguments as to the respective merits of the two systems, with the conclusion that the alternating current will be the equal of the direct in all cases, and its superior in most of them. 1200 w. Elec Wld & Engr—Feb. 21, 1903. No. 53816.

Electrical Power at Sir B. Samuelson and Company's Iron Works, Middlesbrough. Ernest D. Phillips. Illustrated detailed description of the plant and its applications. 4200 w. Ir & Coal Trds Rev —Jan. 30, 1903. No. 53564 A.

Machine Driving.

Power Required to Drive Machine Tools. An account of tests made in the locomotive shops of the Buffalo, Rochester & Pittsburg Ry. at Du Bois, Pa., to ascertain the amount of power used in regular routine work, and also the power lost in shafting and belting. Describes shops. 3500 w. Ir Age—Feb. 12, 1903. No 53525.

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Manchester, N. H.

Electric Water Power at Manchester, N. H. Mills. Illustrated article giving interesting facts in regard to this industrial plant operated with power from distant waterfalls. 1700 w. Elec Wld & Engr—Feb. 14, 1903. No. 53585.

Motors.

Recent Forms of Non-Synchronous Motors with Compensation and Compounding (Asynchron-Maschinen mit Kompensierung und Compoundierung in ihrer Heutigen Ausführung). Alexander Heyland. Describing the improved windings adopted for the latest types of Heyland motor. Three articles. 10,000 w. Elektrotech Zeitschr—Jan. 22, 29, Feb. 5, 1903. No. 53765 each B.

Pumping.

Electric Pumping Plant at the Bridgeport Station, Chicago, for the Illinois & Michigan Canal. Outlines the history of this station established for the purpose of supplying water in time of drought, giving illustrated description of the present plant. 800 w. Eng News—Feb. 19, 1903. No. 53656.

Electric Pumping Plant at Kaiserstuhl II Shaft, Dortmund, Germany. Frank C. Perkins. An illustrated description of the steam plant and electric machinery. 2500 w. Mines & Min—Feb., 1903. No. 53523 C.

Rollers.

Electrical Driven Road Rollers (Rouleaux-Compresseurs à Traction Electrique). A. Dumas. A description of the electrically operated compressing rollers, used for solidifying the earthen dikes of Grosboi's and Saint-Fargean. 1800 w. 1 plate. Génie Civil—Feb. 7, 1903. No. 53719 D.

Rolling Mill.

Electrically Driven Rolling Mill (Eine Elektrisch Betriebene Feinstrasse). F. Janssen. Illustrated description of the new electric equipment of the Bergischen Steel Works at Remscheid, constructed by the Union Elektrizstäts Gesellschaft of Berlin. 2500 w. Stahl u Eisen—Jan. 15, 1903. No. 53758 D.

Shunt-Motor.

Action of a Shunt-Wound Motor when Driven by a Series-Wound Dynamo. A. S. M'Allister. A study of the operation. Ill. 1100 w. Am Electn—Feb., 1903. No. 53434.

Speed Control.

Communications and Discussions. Additions to the discussion of previous papers on variable speed control. 7000 w. Trans Am Inst of Elec Engrs—Jan., 1903. No. 53670 D.

Some Variable Speed Motor Drives. Thomas J. Fay. A discussion of the electrical application of motors to machine tools, with illustrations, methods, and results. 2300 w. Elec Rev, N Y—Feb. 21, 1903. No. 53813.

TRANSMISSION.

Alternators.

Alternators for Electrical Transmission. Alton D. Adams. Considerations as to the number of dynamos in the generating station of a transmission system, describing the three types of alternators used, the voltages, etc. 3700 w. Elec Rev, N Y—Feb. 21, 1903. No. 53812.

Cables.

The Capacity of Cables (Die Kapacität von Kabeln). Dr. Hubert Kath. A discussion of the influence of resonance and Tesla effects upon the capacity of long cables for power transmission. 2000 w. Elektrotech Zeitschr—Jan. 15, 1903. No. 53763 B.

The Sheathing and Protection of Cables (Ueber Kabel Schutzhüllen und Abdeckung deren Verwendung und Verlegung). J. Schmidt. A general and exhaustive discussion of the protection of underground electric cables and the conduits in which they are laid. Serial. Part I. 4000 w. Elektrotech Zeitschr—Jan. 22, 1903. No. 53766 B.

California.

The Generating Transmission and Distribution Systems of the Edison Electric Company of Los Angeles, Cal. George P. Low. An illustrated detailed description of the principal hydraulic, mechanical, and electrical features. 24,800 w. Jour of Elec—Jan., 1903. No. 53627 C.

The Systems of the United Electric, Gas and Power Company. Illustrates and describes the systems at Santa Barbara and Santa Monica. 4500 w. Jour of Elec —Jan., 1903. No. 53629 C.

The Water and Electric Systems of the South Yuba. Rudolph Warner Van Norden. An interesting illustrated detailed description of these systems, with map and engineering data. 13600 w. Jour of Elec —Jan., 1903. No. 53628 C.

Costs.

Costs and Losses of Electric Transmission Lines. Alton D. Adams. Gives a comparison of figures shown in operating a number or representative plants. 2500 w. Mines & Min—Feb., 1903. No. 53520 C.

High-Voltage.

A High-Voltage Power Transmission. M. H. Gerry, Jr. An illustrated description of the various details of the reconstructed plant of the Missouri River Power

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Co. 6600 w. Pro Am Soc of Civ Engrs—Jan., 1903. No. 53351 E.

26,000-Volt Installation at Grenoble, France. C. L. de Muralt. Illustrated description of the plant of the Société Hydro-Electrique de Fure et Morge, which supplies electricity for power purposes to a number of factories. 4000 w. Elec Wld & Engr—Jan. 31, 1903. No. 53432.

Lightning Arrester.

Lightning Arrester for High Tension Currents (Parafoudre pour Haute Tension). A. Bainville. An illustrated description of the Schoen & Felix arrester, made up of elements which can be assembled in any desired number. 1000 w. Electricien—Jan. 31, 1903. No. 53775 B.

Long Distance.

The Power Transmission from St. Maurice to Lausanne (Die Kraftübertragung von St. Maurice nach Lausanne). A description of the hydro-electric station of St. Maurice on the Rhone, Switzerland, and the transmission of 5000 h. p. to Lausanne, 56 kilometres distant. 3000 w. Zeitschr d Ver Deutscher Ing—Jan. 17, 1903. No. 53703 D.

Overhead Wires.

The Computation of Sag of Wires (Berechnung des Drahtdurchhanges). K. Otto. Deducing formulas for the sag of overhead wires for various conditions of tension, temperature, and wind. 2000 w. Elektrotech Zeitschr—Jan. 15, 1903. No. 53762 B.

Polyphase.

Polyphase Work in 1903. A. C. Eborale. Reviews the present position of heavy electrical engineering, indicating some of the lines upon which the work is progressing, and the future outlook. 2200 w. Elec Rev, Lond—Feb. 6, 1903. Serial, 1st part. No. 53609 A.

MISCELLANY.

Address.

Mr. H. A. Earle's Inaugural Address to the Manchester Section of the Institution of Electrical Engineers. Abstract. Brief review of progress during the past 20 years, and subjects connected with electric lighting. 3500 w. Elect'n, Lond—Jan. 30, 1903. No. 53535 A.

Design.

Electrical Design. Reviews papers by Mr. Esson and Mr. E. K. Scott, dealing with the design of electrical machinery. 1000 w. Elec Rev, Lond—Jan. 23, 1903. No. 53471 A.

Education.

The Engineers Who Will Be Wanted. Alfred H. Mayes. Considers the method of training that will best prepare students for electrical engineers. 1900 w. Elec Engr, Lond—Jan. 23, 1903. No. 53474 A.

Fire Hazards.

Some Electrical Fire Hazards. Washington Devereux. An examination of some of the causes that may create a fire from electricity. Also discussion. 6000 w. Pro Engrs' Club of Phila—Jan., 1903. No. 53673 D.

GAS WORKS ENGINEERING

Car Lighting.

See Railway Engineering, Motive Power and Equipment.

Cyanogen.

Cyanogen Recovery. Abstracts of papers by Herr Ritzinger, Dr. Nauss, and Dr. Bueb on the recovery of cyanogen. 4000 w. Gas Wld. Feb. 14, 1903. No. 53680 A.

Fans.

Fans in Gas Works. R. Gordon Mackay. The present article deals with the theory of centrifugal fans, more particularly specialized to the needs of gas engineers. 2500 w. Jour Gas Lgt—Jan. 27, 1903. No. 53479 A.

Gas Engines.

See Mechanical Engineering, Special Motors.

Gas Power.

See Mechanical Engineering, Power and Transmission.

German Practice.

The Progress of the Recovery Coke-Oven in Germany. Digest of a recent article in the *Zeitschrift für Beleuchtungswesen* supplementing the paper of Herr Hilgenstock on "German Coke-Oven Practice" and showing the present trend of affairs in Germany in regard to the manufacture and importation of tar and ammonia. 1100 w. Jour Gas Lgt—Feb. 10, 1903. No. 53684 A.

High-Pressure.

Engineering Works and Shop Lighting by the High-Pressure Gas System. Gives night photographs of the lighting by this system with account of its success. 1700 w. Jour Gas Lgt—Feb. 10, 1903. No. 53682 A.

Illuminants.

Fire Risks of Illuminants. E. Frank Williamson. The present article discusses oil lamps and gas. 1600 w. Aust Min

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Stand—Jan. 1, 1903. Serial, 1st part. No. 53600 B.

India.

The Lighting of Some Indian Cities. A. J. Kennedy. Gives brief accounts of Madras and Jeypore. 1800 w. Gas Wld—Jan. 24, 1903. No. 53477 A.

Invention.

The Trend of Gas Invention. Reviews the patents in the gas field for the last year, comparing it with the year previous. 2700 w. Jour Gas Lgt—Jan. 27, 1903. No. 53478 A.

Leakage.

Gas Leakage and the Public Health. James C. Bayles. Read before the Med. Soc. of the Co. of N. Y. Considers the amount of leakage; what becomes of the gas; the risks of fires and explosions, asphyxiation, blood poisoning and anaemia. etc. 3500 w. Dom Engng—Jan. 25, 1903. No. 53380 C.

Oil Gas.

An Oil-Gas System for Isolated Plants. Shows the worthlessness of some advertised fuel processes, and describes the fuel gas system of the Acme Gas Co. 2200 w. Eng News—Jan. 29, 1903. No. 53313.

"Petrogene."

"Petrogene" Air Gas to Replace Dear Coal Gas. An account of a system being exploited in England, giving plans of plant, and a comparative statement of cost. 3400 w. Jour Gas Lgt—Feb. 3, 1903. No. 53606 A.

Photometry.

See Electrical Engineering, Measurement.

Piping.

Notes on House Piping. Discusses the table proposed by the Research Committee comparing it with other tables. 2000 w. Am Gas Lgt Jour—Feb. 2, 1903. No. 53389.

Prussian Blue.

The Determination of Prussian Blue in Spent Oxide. Abstract translation of a paper by Dr. Luhrig who had made an exhaustive study of this question. 1000 w. Jour Gas Lgt—Feb. 10, 1903. No. 53685 A.

United Kingdom.

Gas Undertakings Returns. Information from the recently issued returns for the United Kingdom. 1500 w. Jour Gas Lgt—Jan. 20, 1903. No. 53327 A.

Water Gas.

Blue Water Gas at Ilford, and Elsewhere. A. G. Glasgow. A statement in defense of the Lowe process. 3700 w. Jour Gas Lgt—Feb. 10, 1903. No. 53683 A.

Some Experiences with Water Gas. Harold E. Copp. Some of the writer's experiences with report of tests made. 1200 w. Jour Gas Lgt—Jan. 20,1903. No. 53328 A.

INDUSTRIAL ECONOMY

Coal Tariff.

The Question of Free Coal. W. Blakemore. An examination of the advantages and disadvantages of a reciprocal free coal agreement between the United States and Canada. 3000 w. Can Min Rev—Jan. 31, 1903. No. 53386 B.

Cost Keeping.

Cost Finding Methods for Moderate-Sized Shops. William Magrutor. A description of the system of the Southern Engine and Boiler Works, employing about 300 men on engines, boilers, and saw-mill machinery. 2500 w. Engineering Magazine—March, 1903. No. 53794 B.

Cost Keeping in Foundries. Edward Kirk. Arguing that nothing of value is gained, and the labor really adds to the cost of castings. 2800 w. Foundry—Feb., 1903. No. 53364.

Education.

Science Workshops for Schools and Colleges. Prof. Henry E. Armstrong. Arguments for training in scientific method, illustrated by reference to the new buildings at Horsham for Christs' Hospital School, and their equipment. Illustrations and discussion. 12500 w. Jour Roy Inst of Brit Archts—Jan. 24, 1903. No. 53678 F.

Exposition.

The International Exposition at St. Louis, 1904 (Die Weltausstellung in St. Louis, 1904). Paul Moller. A general account of the status of the buildings and preparations at the beginning of 1903, as seen by a visiting German engineer. 3000 w. Zeitschr d Ver Deutscher Ing—Jan. 10, 1903. No. 53700 D.

Labor.

The Bloomington Law and Order League. Editorial commending the declaration of this organization and the work it has undertaken to protect all who wish to earn a living. 2000 w. Ir Age—Feb. 12, 1903. No. 53526.

Labor Commission.

The Recent British Trades Unions Visit to the United States. Alfred Mosely. Gives details of things seen by the Mosely

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Commission, the reasons for the visit, and the results looked for. 4000 w. Cassier's Mag—Feb., 1903. No. 53831 B.

Municipal Trading.

The Cost of Municipal Trading. Dixon H. Davies. A detailed discussion of the advantages and disadvantages claimed, with suggestions, also discussion. 15600 w. Jour Soc of Arts—Jan. 30, 1903. No. 53549 A.

Premium System.

The Premium Plan from the Workman's Standpoint. F. A. Halsey. Extracts from an address before the Civic Federation. Gives opinions from various points where the system has been tried all favorable to its working. 2000 w. Ah Mach—Feb. 5, 1903. No. 53450.

The Premium System of Wages (Das Prämiensystem der Arbeiterlöhnung). F. Preuss. A general discussion of the premium system with diagrams comparing day's work and piece work with the systems of Halsey and of Rowan. 2500 w. Zeitschr d Ver Deutscher Ing—Jan. 31, 1903. No. 53709 D.

Profit-Sharing.

Profit-Sharing in America. Editorial discussion of the scheme of the United States Steel Corporation. 3200 w. Engng Jan. 23, 1903. No. 53454 A.

Shipping.

Transatlantic Shipping Business. A discussion regarding the affect of the Morgan combine and Cunard agreement with the British Government, with criticisms of the Cunard agreement. 5000 w. Marine Rev—Feb. 19, 1903. No. 53805.

Trade-Unions.

A Workingman's View of Trade-Unions. James G. Hutchinson. Discusses these associations in England, and suggests improvements in trade-union tactics. 4000 w. Nineteenth Cent—Feb., 1903. No. 53676 D.

Free Shops for Free Workingmen. W. H. Pfahler. Read before the Am. Econ. Assn. Outlines the existing conditions and considers the reasons why employers oppose the "union shop." 2000 w. Ir Trd Rev—Jan. 29, 1903. No. 53383.

Labor Unions and the Law. A. Maurice Low. Discussing the recent Taff Vale decision in England, making unions liable for damages. 1600 w. Rev of Revs—Feb., 1903. No. 53358 C.

Trade Unions and the Law of Conspiracy. A discussion of the proposed bill to be brought before the British parliament. 1400 w. Engng—Feb. 6, 1903. No. 53616 A.

Trusts.

Anti-Trust Bills in Senate and House. Reviews bills so far as they relate to railways. 3400 w. Ry Age—Jan. 30, 1903. No. 53382.

MARINE AND NAVAL ENGINEERING

Auxiliary Motor.

Explosion Motors on Sailing Boats (Les Moteurs à Explosion â Bord des Bateaux de Péche à Voiles). G. Soé. A description of the manner in which auxiliary gasoline motors have been successfully used on French fishing boats. 2000 w. Le Yacht—Feb. 7, 1903. No. 53798 D.

Battleships.

The Chilian Battleship Constitution. Illustration with detailed descriptions of this new vessel, with a comparative table. 1700 w. Engr, Lond—Jan. 23, 1903. No. 53462 A.

Bilge Keels.

The Influence of Bilge Keels on the Resistance and the Rolling of Vessels in Still Water. Johann Schuette. Translated from a paper read before the Schiffbautechnische Gesellschaft, Berlin. An account of experimental investigations with a model, and the interesting results. 1300 w. Marine Engng—Feb., 1903. No. 53408 C.

Boilers.

See Mechanical Engng., Steam Engng.

British Navy.

Science and the Navy. Discusses favorably the new scheme of entry, education and training of officers. 3500 w. Nature—Jan. 29, 1903. No. 53548 A.

The British Naval Engineer Under the New Scheme. Charles M. Johnson. A review of the recent memorandum of the First Lord of the Admiralty regarding the new arrangements of the personnel. 4000 w. Engineering Magazine—March, 1903. No. 53797 B.

Construction.

Approximate Formulas in Ship Construction (Annäherungs-Formeln im Schiffbau. M. H. Bauer. An examination of the working formulas used in ship construction, showing the limits within which approximations may be safely used. Serial, Part I. 2000 w. Schiffbau—Jan. 23, 1903. No. 53787 D.

Cruiser.

The Russian First Class Cruiser "Bogatyr." Illustrated detailed description of vessel designed to meet conditions required by the Russian Government, and of

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the armament, its protection, etc. 4200 w. Engng—Feb. 13, 1903. Serial, 1st part. No. 53694 A.

Ice Breaker.

A Vessel for North Polar Navigation and Discovery. Charles Baillairge. Gives cross-section and brief description of a proposed construction. 1200 w. Can Engr—Feb., 1903. No. 53481.

London.

The Port of London, Benedict W. Ginsburg. Gives a résumé of the position and prospects of this seaport; considering improvements needed for the handling of supplies, dock management, the river, etc. Discussion. 10,000 w. Jour Soc of Arts—Feb. 13, 1903. No. 53679 A.

Motor Boats.

The Construction of Motor Launches. W. F. Durand. Considers the purpose the builders must keep in view and gives hints regarding the construction. Ill. 3800 w. Marine Engng—Feb., 1903. No. 53409 C.

Naval Artillery.

The Tactical Employment of Naval Artillery. Discusses the principles of naval gunnery and the relative bearing and importance of the various artillery questions in the navy. 15,000 w. Trac & Trans—Feb., 1903. No. 53621 E.

Pipe Plan.

Marine Engineering Design—The Pipe Arrangement. J. Calder. Diagram of water and steam connections for the triple-expansion engine and auxiliary machinery of a modern freight steamer of 1,500 I. H. P. and 10 knots speed is given, with explanatory notes. 1200 w. Marine Engng—Feb., 1903. No. 53407 C.

Propeller Shafts.

See Mechanical Engineering, Power and Transmission.

Shipping.

See Industrial Economy.

Steamships.

Notable New American Steamships. Illustrates and describes the Siberia and Korea, two fine vessels intended for service on the Pacific, between San Francisco, Hawaii, Japan and China. 1400 w. Naut Gaz—Feb. 5, 1903. No. 53484.

Tender.

New Light House Tender. Full description and plans of the Magnolia, building for gulf service. 2000 w. Naut Gaz—Feb. 19, 1903. Serial, 1st part. No. 53808.

Vibration.

The Vibrations of Steamships. G. W. Melville. An exhaustive study of the methods of balancing marine engines, reviewing the Yarrow-Schlick-Tweedy system, and showing its inability to provide for the second and higher periods. An important paper by the Engineer-in-Chief of the U. S. Navy. Serial, Part I. 2000 w. Engng—Jan. 2, 1903. No. 53444 A.

Warnings.

Aids to Navigation. Col. William P. Anderson. From an address in Ottawa. Reviews the development of lighthouses, buoys, lightships, etc., on the Canadian shores. 4500 w. Marine Rev—Jan. 29, 1903. No. 53381.

MECHANICAL ENGINEERING

AUTOMOBILES.

Brakes.

Some Notes on Brakes. J. V. S. Bickford. Remarks the tendency to standardization, describes the plans of equalizing the strain of the brake wires, the double-acting brake, etc. 1100 w. Horeless Age—Feb. 11, 1903. No. 53515.

Cooling.

Defective Water Circulation. C. Will Travis. Points out the causes of some of the deficiencies in cooling systems for gasoline engines and suggests an improvement. 1600 w. Horseless Age—Feb. 4. 1903. No. 53483.

Exhibitions.

A Critical Review of the Show. Albert L. Clough. A review of the recent exhibition at Madison Sq. Garden. 3000 w. Horseless Age—Jan. 28, 1903. No. 53319.

Second Annual Automobile Show in Chicago. An illustrated account, with brief descriptions of new cars exhibited and features of interest. 9400 w. Automobile—Feb. 21, 1903. No. 53809.

The American Automobile. Hugh Dolnar. A brief review of the recent exhibition at Madison Sq. Garden, and what it means to the machine trade. 1200 w. Am Mach—Jan. 29, 1903. No. 53307.

The Crystal Palace Automobile Show. Illustrated descriptions of the steam, patrol, and electric cars exhibited. 10,000 w. Motor Car Jour—Feb. 7, 1903. No. 53595 A.

The Crystal Palace Motor Car Show. Editorial review of this London exhibition. 3200 w. Engng—Feb. 6, 1903. No. 53615 A.

The Paris Exhibition of Automobiles. Begins an illustrated description of several of the interesting machines exhibited.

We supply copies of these articles. See page 157.

2300 w. Engng—Jan. 23, 1903. Serial, 1st part. No. 53452 A.

The Show and Its Lessons. Harry B. Haines. Notes improvements, types, sales, etc. 1900 w. Horseless Age—Jan. 28, 1903. No. 53320.

The Stanley Automobile Exhibition. Illustrations and notes concerning the cars exhibited, tires, etc. 3200 w. Auto Jour—Jan. 24, 1903. No. 53476 A.

Gasoline Vehicles.

The Development of the Commercial Gasoline Automobile. Albert L. Clough. Discusses the fuel question, the tire problem, traction in snow, and intelligent operators. 2000 w. Horseless Age—Feb. 4, 1903. No. 53482.

Ignition.

Electric Ignition Generators. Herbert L. Towle. Points involved in their construction and operation for the information of owners and drivers of gasoline cars. 2500 w. Automobile—Feb. 14, 1903. No. 53577.

Motor Vehicles.

Thornycroft Steam Wagon and Patrol Car. Illustrated description of two interesting vehicles shown at the Automobile exhibition in the Crystal Palace. 2500 w. Engng—Jan. 30, 1903 . No. 53558 A.

Petrol Car.

The Chenard and Walcker 10-h. p. Patrol Car. An illustrated description of the general construction of an interesting car remarkable for silence when standing with the engine running, the absence of vibration when traveling, and other improvements. 1800 w. Auto Jour—Jan. 31, 1903. Serial, 1st part. No. 53596 A.

Racer.

America's Swiftest Car, the Baker Electric Racer. Hugh Dolnar. Briefly reviews the rapid development in motor vehicles, and gives an illustrated description of this machine, which claims a speed of 85 miles an hour. 2800 w. Autocar—Jan. 31, 1903. No. 53550 A.

Skidding.

Some Considerations Relating to Skidding Due to Changing the Direction of Motion. E. J. Stoddard. Considers the action of the wheels upon the roadbed, velocity of turning, forces created, etc. Ill. 2000 w. Horseless Age—Feb. 11, 1903. No. 53516.

Steam Vehicles.

A Retrospect of the Steam Vehicle. Hugh Dolnar. Reviews the history of the early attempts to propel vehicles by steam. 2200 w. Automobile—Jan. 31, 1903. No. 53399.

Reliability of Steam Cars in A. C. A. Contest. A comparison between the performances of steam and gasoline cars in the 500-mile reliability test from New York to Boston and return. 2000 w. Automobile—Feb. 14, 1903. No. 53576.

Steam Wagon. Illustrates and describes a wagon exhibited at the recent Crystal Palace show by the Straker Steam Vehicle Co. 1200 w. Engng—Feb. 13, 1903. No. 53695 A.

Touring Car.

The Locomobile Gasoline Touring Car. Illustrated detailed description of designs of A. L. Riker. 2800 w. Horseless Age—Feb. 18, 1903. Serial, 1st part. No. 53640.

Trials.

The Principal Automobile Trials of 1902 (Les Principales Epreuves Automobiles de 1902). F. Drouin. Giving tables of data and results of the more important tests of automobile vehicles during the year 1902. Two articles. 3000 w. Génie Civil—Jan. 24, 31, 1903. No. 53716 each D.

Winter.

Automobiling in Winter (Automobiltahren im Winter). Dr. Karl Dieterich. A discussion of the details of automobile construction necessary for satisfactory operation in cold weather and through snow. 2500 w. Zeitschr d Mitteleurop Motorwagen Ver—Jan. 31, 1903. No. 53781 D.

HYDRAULICS.

Electric Pumping.

See Electrical Engineering, Power Applications.

Elevators.

The Evolution of the Hydraulic Elevator; High-Pressure Elevators in the Prudential Buildings, Newark, N. J. Charles L. Duenkel. A brief historical retrospect with illustrated description of this important installation representative of modern practice. 6000 w. Eng News—Feb. 5, 1903. No. 53412.

Governor.

The Woodward Friction Water Wheel Governor. Illustrated detailed description of a recent design. 900 w. Ir Age—Feb. 4, 1903. No. 53371.

Hydraulic Power.

Precedents in Hydraulic Power Development. Editorial on the recent washout under the power house at Sault Ste. Marie, its cause and the repairs needed. Also discusses the construction of hydraulic works. 1800 w. Eng Rec—Feb. 21, 1903. No. 53835.

Hydro-Electric.

See Electrical Engineering, Generating Stations.

Plumbing.

Water Supply and Distribution in the New York Stock Exchange. Illustrated description of the principal features of this installation. 2100 w. Eng Rec—Feb. 14, 1903. No. 53639.

Pumping Engines.

See Mechanical Engineering, Steam Engineering.

Turbine.

Bucket Forms for the Francis Turbine (Die Schaufelung der Francis-Turbine). R. Escher. A mathematical study of the proportions and curvatures to be given to the buckets of the Francis type of hydraulic turbine. Two articles. 3000 w. Schweiz Bauzeitung—Jan. 17, 24, 1903. No. 53754 each B.

MACHINE WORKS & FOUNDRIES.

Balancing.

Balancing Rotating Parts. Warren E. Willis. Discusses unbalanced conditions and the conclusions that have been reached in regard to the method of correcting them. Ill. 1500 w. Am Mfr—Feb. 5, 1903. No. 53493.

Brass Foundry.

The New Brass Foundry of Siemens & Halske. Paul Wedver. Illustrated description of the new foundry at Charlottenburg, Germany, and its equipment. 3000 w. Foundry—Feb., 1903. No. 53363.

Camming.

Camming Automatic Screw Machines. Reprint of an article by W. A. Jeboult, published in the *Mechanical World*, explaining the principle and demonstrating the method of laying out the cams on the drums of screw machines. Ill. 2600 w. Mach, N Y—Feb., 1903. No. 53397 C.

Car Shops.

See Railway Engineering, Permanent Way and Buildings.

Casting Works.

The Largest Malleable Casting Plant in Europe. Bernhard Osann, in *Stahl und Eisen*. An illustrated description of the Gelsenkirch Casting Works, which claim to be the largest in the world. Their principal product is car wheels, particularly for small mine cars, and axle boxes for the same. 2500 w. Ir Age—Feb. 26, 1903. No 53827.

Cost Keeping.

See Industrial Economy.

Cranes.

Steam and Electric Cranes. Illustrated descriptions of a revolving steam crane having a capacity of 3 tons, and a 50-ton electric crane. 1800 w. Engng—Jan. 30, 1903. No. 53559 A.

Cupolas.

Modern Cupola Practice. F. W. Stickle. Notes the modification in the designs, and the advantages gained, and gives suggestions for rapid and economical melting. 1200 w. Foundry—Feb., 1903. No. 53365.

Finish.

Gun Metal Finish for Steel. B. L. Charles. Describes methods of producing this finish. 700 w. Am Mach—Feb. 12, 1903. No. 53531.

Foundry Management.

Foundry Management in the New Century. Robert Buchanan. Mr. Buchanan's fourth paper discusses the subject of materials of consumption including the purchase of coke, iron, sand, etc. 5000 w. Engineering Magazine—March, 1903. No. 53795 B.

Friction.

Friction in Machinery and Lubrication. D. B. Dixon. Describes tests, showing where the greatest amount of friction is to be found, and how to reduce it. 3000 w. Am Mfr—Feb. 5, 1903. No. 53492.

Gear Cutter.

Automatic Bevel Gear Generating Machine. Illustrated detailed description of a novel and interesting machine for generating theoretically correct bevel gears. 1900 w. Am Mach—Jan. 29, 1903. No. 53306.

Grinding.

Experiments on the Strength of Emery and Carborundum Wheels (Versuche über die Festigkeit van Schmirgel und Karbolundum-scheiben). M. Grübler. An account of experimental tests of the different binding materials used for the manufacture of grinding wheels. 5000 w. Zeitschr d Ver Deutscher Ing—Feb. 7, 1903. No. 53711 D.

Some Points About Grinding. C. H. Norton. On the selection of wheels for various classes of work, the things to be considered, and related matters. 3800 w. Am Mach—Feb. 5, 1903. No. 53448.

Knife Making.

Making the Press Button Knife. C. Neil. Illustrated description of a knife in which all the parts, excepting the blade, are made by machinery. Also describes the tools and methods. 2000 w. Am Mach—Feb. 5, 1903. No. 53446.

Milling Machines.

Milling Machine Feeds. Considers the usual methods of driving the feed of a milling machine, and the advantages of each: troubles that occur and their remedies; features, and desirable improvements. 3300 w. Engr, Lond—Jan. 30, 1903. No. 53560 A.

Molding.

Gates and Sprues. B. D. Fuller. Gives

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some examples of improper gating, and discusses forms of gates and their uses. 1900 w. Ir Trd Rev—Feb. 5, 1903. No. 53417.

New Shops.

The Great West-Allis Plant of the Allis-Chalmers Company, Milwaukee, Wis. An illustrated description of an immense plant, nearly completed, for machine building. 3000 w. Mach, N Y—Feb., 1903 No. 53396.

The Witton Works of the General Electric Company, Limited. Plan, and illustrated detailed description of the works thus far developed. 3800 w. Elec Engr, Lond—Feb. 13, 1903. No. 53688 A.

The New Shops of the Armour Institute of Technology. G. F. Gebhardt. Illustrated description of this fine shop building, recently completed, in Chicago. 1000 w. Am Mach—Feb. 12, 1903. No. 53530.

Patterns.

The Use of Aluminum for Patterns. Harland Tuttle, in the *Aluminum World*. States some of the advantages due to the lightness of aluminum, and gives advice and suggestions in regard to its use. 1200 w. Foundry—Feb., 1903. No. 53366.

Sheet Metal.

Curling and Wiring Processes. Joseph V. Woodworth. Illustrates and describes press tools and fixtures for sheet metal work. The article is confined to tools for curling and wiring. 1000 w. Am Mach—Feb. 5, 1903. No. 53445.

Steel Castings.

See Mining and Metallurgy, Iron and Steel.

Steel-Works.

The Port Talbot Steel-Works and Their Equipment. Illustrated detailed description of these important works in South Wales. 2800 w. Ir & Coal Trds Rev—Feb. 6, 1903. No. 53620 A.

Tools.

Cutting Angles of Tools for Metal-Work as Affecting Sneed and Feed. H. F. Donaldson. An account of experimental study to determine the best cutting angles for rapid cutting tool-steels. The experiments covered 14 different qualities of material. Ill. 4300 w. Inst of Mech Engrs—Jan. 16, 1903. No. 53370 D.

The Sub-Press. F. C. Fladd. Illustrated detailed description of a tool for punching very accurate work. 1000 w. Am Mach—Feb. 5, 1903. No. 53447.

Valuation.

The Valuation of Pig Iron for Foundry Purposes. Dr. Richard Moldenke. Discusses the opinions advanced in regard to the writer's suggestion for standard methods of valuing pig iron. 2000 w. Jour Am Found Assn—March, 1903. No. 53566.

MATERIALS OF CONSTRUCTION.

Abrasives.

Crushed Steel and Steel Emery. M. M. Kann. Read before the Am. Assn. for the Adv. of Science. Brief history of these products, their manufacture and uses. 2200 w. Ir Age—Jan. 29, 1903. No. 53305.

Aluminum.

Working Aluminum. H. Robinson. Considers the difficulties encountered, and how to avoid trouble. 900 w. Am Mach—Feb. 5, 1903. No. 53449.

Brass.

The Effect of Tellurium on Brass. Erwin S. Sperry. Experimental investigations of the influence of tellurium on the properties of brass. In small amounts it does not seem injurious; in comparatively large amounts it appears to impart cold-shortness to high-brass. 1400 w. Trans Am Inst of Min Engrs—Feb. & May, 1902. No. 53336.

Cast Steel.

See Mining and Metallurgy, Iron and Steel.

Expansion.

The Expansion of Tempered Steel (Sur la Dilatation des Aciers Trempés). MM. Charpy & Grenet. A discussion of the effect of the carbon content upon the coefficient of expansion. 1000 w. Comptes Rendus—Jan. 12, 1903. No. 53733 D.

Mercury.

An Effective Mercury Cleaning Device. A. O. Doane. Illustrates and describes a device which furnishes a reliable means of cleaning mercury for pressure gauges. 900 w. Eng Rec—Feb. 21, 1903. No. 53839.

Metallography.

See Mining and Metallurgy, Iron and Steel.

Nickel Steel.

Recent Investigations upon the Expansion of Nickel Steel (Nouvelles Recherches sur la Dilatation des Aciers au Nickel). C. E. Guillaume. Determinations of expansion coefficients of minimum-expansion alloys, with discussion of the influence of carbon silicon, and manganese upon the expansion. 1200 w. Comptes Rendus—Feb. 2, 1903. No. 53737 D.

The Micrography of Nickel Steel (Sur la Micrographie des Aciers au Nickel). Léon Guillet. A discussion of the structure of various nickel steels as revealed by the methods of metallography. 1200 w. Comptes Rendus—Jan. 26, 1903. No. 53736 D.

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Steel Castings.

See Mining and Metallurgy, Iron and Steel.

Testing.

Drop Tests of Nicked Bars (Les Essais au Choc sur Barreaux Entailles). M. Abraham. A discussion of the methods of Barba and Frémont for determining the strength of metals by the drop test upon small nicked bars. Serial, part I. Revue Technique—Jan. 10, 1903. No. 53720 D.

New Viewpoints in the Testing of Materials (Ueber Einige Neuere Gesichtspunkte in Materialprüfungswesen). B. Zschokke. An examination of the progress which has been made in the testing of materials, including improved drop tests, chemical examination, metallography, etc. Two articles, 2500 w. Schweiz Bauzeitung —Jan. 31, Feb. 7, 1903. No. 53756 each B.

Tool-Steel.

The Taylor-White Process of Testing Tool-Steel. Report of the Committee on Science and the Arts on the invention of Maunsel White and Fred W. Taylor. 2500 w. Jour Fr Inst—Feb., 1903. No. 53574 D.

Wire Testing.

A New Method of Testing Wire. Arthur Falkenau. A brief illustrated description of the Moore testing apparatus, with explanation of its use. 900 w. Pro Engrs' Club of Phila—Jan., 1903. No. 53675 D.

MEASUREMENT.

Computer.

The Screw-Propeller Computer. Illustrated description of a computer designed by Prof. McDermott, explaining its use. 700 w. Sib Jour of Mech Engng—Jan. 1903. No. 53660 C.

Contacts.

The Measurement of Contacts. Harvey D. Williams. Explains how such measurements can be made, and that when the method is applied to gear teeth it brings out facts of importance. Ill. 2500 w. Am Mach—Feb. 19, 1903. No. 53650.

Dynamometer.

A Transmission Dynamometer. Fred S. English. Illustrated description of a form of dynamometer similar in principle to the Webber Balance Dynamometer but differently applied. 600 w. Am Mach—Feb. 12, 1903. No. 53529.

Metric System.

Metric Measurements. Robert H. Smith. Reviews arguments presented in a recent debate before the British Inst. of Elec. Engrs., and gives the writer's views. 2800 w. Elec Rev, Lond—Feb. 13, 1903. No. 53690 A.

POWER & TRANSMISSION.

Belts.

Belting. W. D. Spooner. Considers the essentials of a good belt, the materials used, the placing in position and other points. 2800 w. Engr, U S A—Feb. 16, 1903. No. 53646.

Compressed Air.

Safe Ratios in Air Compression. Fred v. D. Longacre. On the determination of the maximum ratio of compression that can be used in a single cylinder with safety. Also editorial. Ill. 3500 w. Compressed Air—Feb., 1903. No. 53814.

Efficiency.

The Efficiency of Prime Movers and of Machines. An explanation of Prof. Rankine's method of determining efficiency. 1000 w. Engr, Lond—Jan. 23, 1903. No. 53461 A.

Gas Power.

The Blast Furnace as a Power Plant. Edward A. Uehling. Shows the importance of the blast furnace as a source of power and the efficiency of the gas engine as a prime mover. 3300 w. Stevens Ind —Jan., 1903. No. 53658 D.

The Direct Utilization of Furnace Gas for Power Generation (Die Direkte Verwertung der Gichtgase zur Energieerzeugung). H. Thimm. A general discussion of the use of furnace gas in large gas engines, with plate showing variations in speed and power. 3000 w. 1 plate. Glückauf—Feb. 7, 1903. No. 53747 B.

Grain Elevator.

A New Derrick or "Grasshopper" Elevator for Unloading Grain from Vessels. Illustrates and describes a machine in use at the London docks. 2000 w. Sci Am—Jan. 31, 1903. No. 53316.

Motor Power.

Census Report on Motor-Power Appliances. Edward H. Sanborn. Re-print of U. S. Census Report of statistics relating to the manufacture of appliances used for the generation of power, excluding locomotives and motor vehicles. 7800 w. Power—Feb., 1903. No. 53332 C.

Natural Sources.

Power from the Interior Heat of the Earth. William Hallock. Considers the amount of energy brought to the surface in the form of hot water from hot springs, and the temperatures of deep mines, etc., and discusses the utilizing the heat below the surface of the earth. Ill. 2200 w. Cassier's Mag—Feb., 1903. No. 53830 B.

Prony Brake.

Graphical Diagram for Brake Tests (Graphische Rechen tafel für Bremsversuche). Dr. F. Prasil. Constructing a diagram enabling the efficiency and load

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curves to be compared in Prony-brake tests of turbine water wheels. 600 w. Schweiz Bauzeitung—Feb. 7, 1903. No. 53757 B.

Rope Transmission.

Transmission with Endless Cables (Transmissions par Cables sans Fin). G. Mohr. A description of the American system of rope transmission, using an endless rope with several turns about the pulleys, and with a weighted tension idler. 1000 w. Génie Civil—Jan. 31, 1903. No. 53718 D.

Shafting.

Shafting Hints. Charles Herrman. Suggestions for remedying troubles. Ill. 3000 w. Power—Feb., 1903. No. 53330 C.

Torsion and Torsional Stresses in Propeller Shafts. Translations of a portion of a recent discourse by Mr. Hermann Frahm describing some interesting and novel experiments made investigating the dynamic forces acting in revolving propeller shafts. Ill. 3300 w. Engng—Feb. 6, 1903. No. 53617 A.

Spiral Gears.

Spiral Gears of Equal Diameters on Shafts at Right Angles. F. A. Halsey. Explanation, with practical examples. Supplementary to previous articles by the writer. 800 w. Am Mach—Feb. 19, 1903. No. 53651.

SPECIAL MOTORS.

Alcohol.

The Phenomena of Combustion in Stationary Alcohol Motors (Sur les Phénomènes de la Combustion dans les Moteurs Fixes à la Alcool). M. Sorel. An account of the laboratory investigations of the action of alcohol as a fuel in internal combustion motors at the exhibition at Paris in May, 1902. Serial, Part 1. 6000 w. Revue de Mécanique—Jan. 31, 1903. No. 53728 E + F.

Benzine Motor.

Comparative Tests of Benzine and Alcohol Motors (Vergleichende Versuche an einem Explosionsmotor mit Benzin und Spiritusbetrieb). A discussion of tests using the different fuels in the same engine under varying degrees of compression. 2500 w. Zeitschr d Ver Deutscher Ing—Jan. 10, 1903. No. 53702 D.

Gas Engines.

Brake Test of a Gas Engine. Alfred E. Lüders. Hints upon determining the horse power of an engine by what is commonly known as the brake mehod. 1200 w. Marine Engng—Feb., 1903. No. 53410 C.

Butler's Three-Cylinder Compound Gas Engine. Illustrated description of an engine of vertical type having novel features. 1000 w. Mech Engr—Jan. 31, 1903. No. 53551 A.

Gas Engines for Electric Lighting. H. B. Graham. Abstract of a paper read before the Birmingham Local Sec. of the Inst. of Elec. Engrs. and of the discussion. Discusses results obtained, the flywheel problem, balancing, bearings, etc. 3300 w. Elect'n, Lond—Jan. 30, 1903. No. 53554 A.

Sizes of Parts of Gas Engines. H. H. Kelley. Gives simple formulas for finding the sizes of parts based on the diameter of the cylinder within stated limits. Ill. 2200 w. Engr, U S A—Feb. 2, 1903. No. 53419.

Test of a Charon Gas Engine. R. Mathot. An account of tests made of an engine and producer gas power-plant installed at Winterthur (Switzerland). 900 w. Power—Feb, 1903. No. 53329 C.

Gas Fuels.

Gas Fuels for Modern Engines. George E. Walsh. Considers briefly the advance in engines of large units, those operated by natural gas; those adapted to use poor gas; and furnace gas engines. 2700 w. Ir Age—Jan. 29 1903. No. 53303.

Gasoline.

See Marine and Naval Engineering.

See Mechanical Engineering, Automobiles.

Internal Combustion.

Investigations upon Internal-Combustion Motors (Versuche mit Verbrennungsmotoren). Emil Schimanek. Discussing especially the improved Banki motor, in which a spray of water is injected into the charge. 4000 w. Zeitschr d Ver Deutscher Ing—Jan. 17, 1903. No. 53704 D.

STEAM ENGINEERING.

Blowing Engines.

Blowing Engines at the Priors Lee Furnaces. Illustration and drawings of a set of vertical compound blowing engines recently erected, the first, in England, fitted with positive valve gear and blowing at high pressure. Brief description. 500 w. Engr, Lond—Feb. 13, 1903. No. 53697 A.

Boiler Economy.

The Betterment of Steam-Boiler Economy. E. S. Farwell. An analysis of efficiency losses in steam generation, with suggestions for possible improvement. 2500 w. Engineering Magazine—March, 1903. No. 53796 B.

Boiler Explosions.

Lessons from Recent Steam Boiler Explosions (Einige Hauptlehren aus Dampfkesselexplosionen der jüngsten Zeit). C. Bach. A discussion of recent boiler explosions in Germany, with an analysis of

causes. 2500 w. Zeitschr d Ver Deutscher Ing—Jan. 31, 1903. No. 53708 D.

Boiler Feeders.

Oil and Compound Feeders for Boilers. James F. Hobart. Illustrated discussion of appliances for feeding evenly. 1400 w. Am Electn—Feb., 1903. No. 53436.

Boilers.

Externally-Fired Boilers. William H. Fowler. States the advantages of external firing, considering two types of boilers. Ill. 1500 w. Mech Engr—Feb. 7, 1903. No. 53601 A.

Heating Boiler Development. H. J. Barron. Discusses heating boilers their merits and drawbacks. Ill. 1500 w. Engng Rev—Jan., 1903. No. 53322.

Modern Marine Boilers. A consideration of the Relative Advantages of Various Types. Discusses only those in use on at least a half-dozen steam vessels. 3200 w. Engrs' Gaz—Feb. 1903. Serial, 1st part. No. 53603 A.

The Efficiency of Boiler Furnaces. Extracts from a memorandum recently issued by C. E. Stromeyer, dealing with matters relating to the working of steam boilers. 3500 w. Mech Engr—Feb. 14, 1903. No. 53681 A.

Water-Tube Naval Boilers. Concerning the Admiralty trials of the gunboat Sheldrake and sloop Espiegle, fitted with Babcock and Wilcox water-tube boilers; and the Seagull and Fantome, fitted with the Niclausse water-tube boilers. 2200 w. Engrs' Gaz—Feb., 1903. No. 53602 A.

Chimneys.

Chimney Notes. William Wallace Christie. Illustrated description of the tearing down of a large chimney in Paterson, N. J., and considers various features of brick chimneys. 1500 w. R R Gaz—Feb. 13, 1903. No. 53545.

Combustion.

Combustion. W. D. Spooner. Gives results of some experiments made in an attempt to secure economy. 5400 w. Engr, U S A—Feb. 16, 1903. No. 53647.

Condenser.

The Central Condensation Plant of the Heinitz Mine at Saarbruck (Die Zentral Kondensation der Königlichen Heinitzgrube bei Saarbrücken). G. W. Koehler. Illustrated description of a central condensing plant with Klein cooling towers, for handling 12,000 kilogrammes of steam per hour. 2000 w. 1 plate. Glückauf—Jan. 17, 1903. No. 53741 B.

Engines.

A New High-Speed Engine. Illustrated description of Hoy's high-speed, single-acting, compound engine, which is extensively used on the Lancashire and Yorkshire Railway. 800 w. Engr, Lond—Jan. 30, 1903. No. 53563 A.

Some Steam Engine Installations at Twente (Einige Machine-Installaties Uitgevoerd in Twente). E. Looman. With illustrations of compound engines recently installed in textile works of Gronan, Ryssen, and Borne, Holland. 2500 w. 3 plates. De Ingenieur—Jan. 24, 1903. No. 53738 D.

Entropy.

Entropy: An Elementary Exposition. Sir Oliver Lodge. An article in response to a special request explaining this term of thermodynamics. 5000 w. Elect'n, Lond—Jan. 23, 1903. No. 53472 A.

Entropy. Prof. H. Poincaré. A contribution to the controversy about entrophy. 2700 w. Elect'n, Lond—Feb. 13, 1903. No. 53692 A.

Entropy. Prof. John Perry. The writer's explanation of the term. 1800 w. Engr, Lond—Jan. 23, 1903. No. 53460 A.

Entropy. Robert H. Smith. A contribution to the discussion of this term, especially referring to the paper by Prof. John Perry. 1600 w. Engr, Lond—Jan. 30, 1903. No. 53562 A.

Flywheels.

A Convenient Rule for Computing Maximum Revolutions for Flywheels. William H. Boehm. From the monthly bulletin of the Fidelity & Casualty Co. Gives a rule based upon the practice of allowing a rim-speed of one mile per minute for well-made cast-iron wheels. 200 w. Eng News—Jan. 29, 1903. No. 53308.

Governors.

The Theory of Steam-Engine Governors (Note sur la Théorie des Régulateurs). V. Dwelshauvers-Dery. An examination of the conditions of isochronous regulation of steam engine speed by centrifugal governors, and the extent to which it can be attained in practice. 8000 w. Revue Mécanique—Jan. 31, 1903. No. 53727 E + F.

Horse-Power.

Boiler Horse-Power for Heating and Power. Charles L. Hubbard. Gives methods of computing, based on 15 sq. ft. per H. P. 1800 w. Mach, N Y—Feb., 1903. No. 53398.

Indicators.

Notes on the Testing of Indicator Springs (Beiträge zur Prüfung von Indikatorfedern). H. F. Wiebe & R. Schwirkus. A discussion of the methods for testing indicators used at the Reichsanstalt and advocating the placing of the spring out of contact with the steam. 3500 w. Zeitschr d ver Deutscher Ing—Jan. 10, 1903. No. 53701 D.

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Typical Examples of Defective Indicator Diagrams. Extract from a paper by A. Marshall Arter read before the Civ. & Mach. Engrs' Soc. Valuable notes on defective indicator diagrams, with the causes that produced them. 4500 w. Mech Engr —Jan. 24, 1903. No. 53466 A.

Oil Fuel.

Notes on Burning Crude Oil in Scotch Boilers. H. S. Markey. Suggestions for the successfud burning of oil, noting the troubles experienced. 1300 w. Marine Engng—Feb., 1903. No. 53405 C.

Oil Separator.

The Relation of the Efficiency of an Oil Separator to the Quality of Oil Used (Abhangigkeit der Wirksamkeit des Oelabschneiders von der Beschaffenheit des den Dampfzylindern Zugeführten Oeles). C. Bach. A brief account of tests upon a separator showing the variations in results obtained by feeding different oils into the steam cylinder. 1000 w. Zeitschr d Ver Deutscher Ing—Feb. 7, 1903. No. 53712 D.

Piping.

High Pressure Steam Piping. William Andrews. Read before the Engine Builders' Assn. Discusses the design, the quality of the material, and the disposing of the water. 2400 w. Met Work—Feb. 14, 1903. No. 53532.

Pipe Fittings. John H. Ryan. Suggestions with illustrations. 1800 w. Engr, U S A—Feb. 2, 1903. Serial, 1st part. No. 53420.

See also Marine Engineering.

Pumping Engines.

Maximum Duty of a Pumping Engine with 1,000 Pounds of Steam. A. F. Nagle. A calculation of the duty of an ideal engine under practical conditions. 1700 w. Engr, U S A—Feb. 2, 1903. No. 53421.

Safety-Valves.

Safety-Valve Springs. H. K. Spencer. Gives formulas for both round and square steel and considers how such springs are proportioned. 600 w. Marine Engng—Feb., 1903. No. 53406 C.

Speed.

Changing the Speed of Engines. W. H. Wakeman. An explanation of the principles involved. Ill. 900 w. Power—Feb., 1903. No. 53331 C.

Steam Heating.

General Rules for Low-Pressure Steam Heating (Zur Erzeilung der Generellen Regetung der Niederdruck dampfheizungen). H. Rietschel. A development of working formulas with examples of their practical application. 6000 w. Gesundheits-Ingenieur—Jan. 31, 1903. No. 53788 B.

Steam Turbines.

Steam Turbines for the Massachusetts Electric Companies. Illustrates and describes details of the installation at Newport, R. I. 1800 w. Steam Engng—Feb. 10, 1903. No. 53528.

Steam Turbines of the Massachusetts Electric Companies. Plans and general description of this new steam turbine power plant. The first plant to receive the turbine equipment is at Newport, R. I. 1800 w. St Ry Rev—Feb. 20, 1903. No. 53820 C.

Steam Turbines for Power Stations and Factories. Abstract of a paper read before the Manchester Assn. of Engrs. The present article gives an illustrated description of the action of the De Laval steam turbine. 2200 w. Prac Engr—Feb. 6, 1903. Serial, 1st part. No. 53594 A.

The Steam Turbine. H. M. Gleason. States the general advantages over the reciprocating engine, and the special advantages for the propulsion of ships. 1500 w. Sci Am—Feb. 21, 1903. No. 53822.

Superheating.

The Advantages and Disadvantages of the Superheated-Steam Locomotive (Für und Wider die Heissdampflokomotiv). H. Teuscher. A discussion of the Schmidt locomotive, comparing its economy with the modern compound locomotive. 2500 w. Zeitschr d Ver Deutscher Ing—Jan. 24, 1903. No. 53707 D.

Valve Gears.

Recent Valve Gear Devices (Sur Quelques Dispositions Récentes de Distributions par Soupapes). M. Svilokossitch. Illustrating and describing recent poppet valve gears for steam engines. Serial, Part I. 2000 w. Revue Technique—Jan. 25, 1903. No. 53721 D.

MISCELLANY.

Aeronautics.

The Airship System of M. Frederick L'Hoste. Dr. T. Byard Collins. Brief illustrated description. 1200 w. Sci Am Sup— Feb. 14, 1903. No. 53535.

Artillery.

A Sketch of the Origin and Development of Artillery. W. J. Peirce. Considers those engines employing gunpowder, or a similar explosive agent, as a propelling force; also the carriage, the powder and projectiles. 6000 w. Yale Sci M—Jan., 1903. No. 53301 C.

Test of the New 16-Inch Gun. An account of the test of the new United States army 16-inch gun at the Sandy Hook proving ground. Ill. 1100 w. Sci Am—Jan. 31, 1903. No. 53315.

Mechanics.

The Evolution of Mechanics (L'Evolution de la Mécanique). P. Duhem. A re-

view of the history of the growth of the study of mechanics, from the earliest times to the present. Serial, Part I. 5000 w. Rev Gen des Sciences—Jan. 30, 1903. No. 53729 D.

Refrigeration.

A Calcium Chloride Cooler. J. A. Mermilliod. Gives the writer's experience in overhauling a poorly equipped ice plant and connecting cold storage department, and illustrates and describes the cooler. 1200 w. Ice & Refrig—Feb. 1903. No. 53451 C.

Slide Rule.

Mechanical Aids to Computation (Einige Hulpmiddelen voor hel Rekenen). F. J. Vaes. A description of the improved slide rule and tables of Proell for facilitating numerical computations. 3000 w. De Ingenieur—Feb. 7, 1903. No. 53740 D.

Type-Setting.

The Inventions of Dr. William Church —The First Patented Type-Casting and Composing Machine. Illustrates and describes a machine patented in 1822. 2300 w. Sci Am—Feb. 14, 1903. No. 53534.

MINING AND METALLURGY

COAL & COKE.

Anthracite.

The Anthracite Situation. Robert Lincoln O'Brien. A discussion of coal prices and the systems regulating them; causes of shortage; the attitude of operators and miners, etc. 1600 w. Eng & Min Jour—Jan. 31, 1903. No. 53440.

The Welsh Anthracite Coal Trade. An interesting article giving much information in regard to the collieries, deposits, etc., in Wales, as well as discussing the trade. 3500 w. Ir & Coal Trds Rev—Jan. 23, 1903. No. 53464 A.

Briquetting.

The Briquetting of Flue Dust, Fine Ore and Fuel. Considers this method of utilizing fine material, the machines used, and the results. Ill. 9500 w. Eng News—Feb. 12, 1903. No. 53537.

Bunkers.

Coal-Bunker Plant at a German Colliery. Stach, in *Glückauf*. Brief description with illustration of the plant and its operation. It is claimed to give economical results and cleanliness. 600 w. Col Guard—Jan. 23, 1903. No. 53458 A.

Coal-Cutting.

Notes on Coal-Cutting by Machinery. A. Dury Mitten.. Abstract of paper and discussion before the Manchester Geol. Soc. Considers the circumstances under which coal-cutting machines can be adopted; what machine and motive power is best; and the benefit. 2300 w. Ir & Coal Trds Rev—Feb. 13, 1903. No. 53800 A.

Coal Tariff.

See Industrial Economy.

Coal-Washing.

Coal-Washing Plant at an Austrian Colliery. H. Hoefer, in *Oesterreichische Zeitschrift für Berg- und Huttenwesen*. Illustrated description of a plant using the Elliott system with six troughs. 900 w. Col Guard—Jan. 23, 1903. No. 53457 A.

Coking.

Coking in Bee-Hive Ovens with Reference to Yield. Charles Catlett. A discussion of the factors affecting the yield. 3300 w. Am Gas Lgt Jour—Feb. 2, 1903. No. 53390.

Deposits.

The Coal Deposits of the Northwest. Frank A. Wilder. Gives an account of the extensive deposits of bituminous coal and lignite, although no anthracite has been found. 2500 w. Rev of Revs—Feb., 1903. No. 53357 C.

Lignites.

The Fuel Value of the North Dakota Lignites. Frank A. Wilder. Information in regard to the quality, the uses to which it may be applied, results of tests, etc., Ill. 2000 w. Eng & Min Jour—Feb. 7, 1903. No. 53512.

New Zealand.

The Buller Coalfields (N. Z.) Sydney Fry. Information of their extent and quality, and their probable continuity beyond the limits prospected. 1100 w. Aust. Min Stand—Jan. 1, 1903. No. 53598 B.

Rocky Mountains.

The Efficiency of Some Rocky Mountain Coals. W. H. Williams. Read before the Montana Soc. of Engrs. Describes tests made of these coals, and gives results. 1600 w. Jour Assn of Engng Socs—Dec., 1902. No. 53664 C.

COPPER.

Arizona.

Developments Near Bisbee, Arizona. D. E. Woodbridge. Report of this valuable copper district. 1200 w. Eng & Min Jour—Feb. 7, 1903. No. 53513.

The Verde Mining District, Yavapai County, Arizona. Illustrated description of this famous copper mining district.

We supply copies of these articles. See page 157.

1300 w. Min & Sci Pr—Jan. 31, 1903. No. 53485.

Copper Slag.

Report on a Co-operative Chemical Analysis of a Copper Slag. Thorn Smith. Gives the methods of analysis and results, discussing them in detail. 4500 w. Eng & Min Jour—Feb. 21, 1903. No. 53815.

Extraction.

The Elimination of Arsenic, Antimony and Bismuth from Copper. Allan Gibb. A study of the elimination effected in the various metallurgical operations. 4800 w. Trans Am Inst of Min Engrs—Oct., 1902. No. 53334 D.

New Mexico.

The Copper-Deposits of the Sierra Oscura, New Mexico. H. W. Turner. Describes these deposits and discusses the commercial value of the ore. 1300 w. Trans Am Inst of Min Engrs—Oct., 1902. No. 53338.

Nickel-Copper.

Note of the Condition of Platinum in the Nickel-Copper Ores from Sudbury Charles W. Dickson. Gives results of experimental investigations. 1100 w. Am Jour of Sci—Feb., 1903. No. 53369 D.

Santiago de Cuba.

El Cobre Copper Mines, Santiago de Cuba. A. E. Heighway. A brief account of the history and present development of these mines which produced $48,000,000 during a period of 18 years. Ill. 1000 w. Eng & Min Jour—Feb. 7, 1903. No. 53510.

South Africa.

Copper in Rhodesia, South Africa. Reviews the reports of T. G. Davey and J. F. Jones, and discusses the prospects. 2500 w. Ir Age—Feb. 19, 1903. No. 53625.

Sweden.

Recent Discoveries of Copper Ore in Norrbotten (Neue Kupfererzfunde in Norrbotten). E. Svedmark. A brief account of the recent discoveries of copper ore in the extreme north of Sweden. 600 w. Glückauf—Jan. 31, 1903. No. 53745 B.

GOLD AND SILVER.

Assaying.

An "All-Fire" Method for the Assay of Gold and Silver in Blister-Copper. Walter G. Perkins. Describes the process used and states the advantages of the method. 1500 w. Trans Am Inst of Min Engrs—Oct., 1902. No. 53341 C.

Central America.

Copper, Silver, and Gold in Central America. Reports concerning Honduras, Nicaragua and Salvador. 2500 w. U S Cons Repts, No. 1565—Feb. 7, 1903. No. 53426 D.

Chile.

Copper, Silver and Gold in Chile. A report of the mineral resources and mining industry. 2800 w. U S Cons Repts, No. 1564—Feb. 6, 1903. No. 53401 D.

Concentration.

A Modern Coarse Concentration Plant for Silver Lead Ore. Ernest R. Woakes. Read before the Inst. of Min & Met. An illustrated detailed description of the Highland Concentrator at Ainsworth, B. C. with information of the capacity and cost of operation. 5400 w. Can Min Rev —Jan. 31, 1903. No. 53387 B.

The Concentration of Ores by Oil. Walter McDermott. A description of the Elmore process. Ill. 1500 w. Eng & Min Jour—Feb. 14, 1903. Serial. 1st part. No. 53632.

The Elmore Process of Concentration by Oil. W. H. Booth. Describes this method adapted for saving finely divided floating particles of ore or metal. 2000 w. Mines & Min—Feb., 1903. No. 53517 C.

Cyanide.

Notes on Commercial Cyanide of Potash. A. Whitby. Report of investigations made showing how wide the difference may be in the composition while still retaining the percentage claimed. 1100 w. Jour Chem & Met Sci of S Africa—Dec. 1902. No. 53590 E.

Notes on the Analysis of Cyanide Solutions. A letter from W. H. Virgoe, in contribution to the discussion of a paper by Andrew F. Crosse. 1200 w. Jour Chem & Met Soc. of S Africa—Dec., 1902. No. 53589 E.

The Cyanide Process in Montana. Matt. W. Alderson. Abstract of a report to the Bureau of Agriculture, Labor, and Industry, Montana. Gives statistics of production by cyanide since 1896, showing increase. 900 w. Eng & Min Jour—Feb. 7, 1903. No. 53511.

Dry Ores.

The Dry Ores of Slocan, B. C. Ronald C. Campbell-Johnston. Describes these deposits, the characteristics of the ores, and the treatment they require. Gold is carried in arsenides and sulphides of iron; the silver occurs native, or as sulphides, or alloyed. 800 w. Min & Sci Pr—Jan. 24, 1903. No. 53377.

Georgia.

The Dahlonega Gold District of Georgia. Edwin C. Eckel. Gives the general geology of the region, the ores and ore-deposits and related information. 2500 w. Eng & Min Jour—Feb. 7, 1903. No. 53509.

Mexico.

Notes on Certain Mines in the States of Chihuahua, Sinaloa and Sonora, Mexico.

We supply copies of these articles. See page 157.

Walter Harvey Weed. Observations made during recent trips, giving a description of the geology of this region famous for its gold and silver mines. Ill. 12400 w. Trans Am Inst of Min Engrs—Nov., 1901. No. 53346 D.

The Mining District of Parral, State of Chihuahua, Mexico. G. A. Burr and Louis S. Cates. The first of a series of articles aiming to give a concise review of this promising region, which has been mined for several centuries for gold and silver ores. Map. 1800 w. Eng & Min Jour—Feb. 7, 1903. Serial, 1st part. No. 53507.

Milling.

Mill of the Melones Mining Co. at Melones, Calaveras County, Cal. Walter W. Bradley. Illustrates and describes the milling equipment. The plans call for 120 stamps and 60 have been in operation since April, 1902. 1500 w. Min & Sci Pr—Jan. 24, 1903. No. 53376.

Mining Reports.

Copper, Silver, and Gold in the Argentine Republic and Brazil. Reports from consular officers in Latin America on mining in their districts. 3000 w. U S Cons Repts, No. 1562—Feb. 4, 1903. No. 53-372 D.

Mongolia.

Silver-Mining and Smelting in Mongolia. Yang Tsang Woo. Describes the methods employed by the natives. Ill. 1200 w. Trans Am Inst of Min Engrs—Feb. & May, 1902. No. 53337.

Ore-Deposits.

Basaltic Zones as Guides to Ore-Deposits in the Cripple Creek District, Colorado. E. A. Stevens. Describes the rock-types and the dike of quartz-porphyry associated with all the paying mines of this district, considering them as the true and only guides to the opening of mines in Cripple Creek. 3800 w. Ill. Trans Am Inst of Min Engrs—Feb. and May, 1902. No. 53343 C.

Panning.

How to Pan Gold from Gravel. Taken from the printed instructions, by Prof. Henry S. Monroe, for students in the ore dressing laboratory of the School of Mines, Columbia Univ., New York. 1200 w. Eng News—Feb. 12, 1903. No. 53638.

Precipitation.

Precipitation of Coppery Cyanide Solutions. R. Stuart Browne. Points from the writer's experience in leaching ores containing copper. 1200 w. Min & Sci Pr—Jan. 24, 1903. No. 53378.

Smelting.

The Lead Smelting of Zinc Gold Slimes. Continued discussion of paper by P. S. Tavener. 2000 w. Jour Chem & Met Soc of S Africa—Dec., 1902. No. 53592 E.

Sorting.

Sorting at Johannesburg. T. Lane Carter. A brief account of a test being tried where no attempt is made to sort out the waste. 1200 w. Eng & Min Jour—Feb. 7, 1903. No. 53506.

Valuation.

Notes on Valuing a Gold Mine. T. Lane Carter. Mr. Carter's reply to the discussion on his paper. 3000 w. Jour Chem & Met Soc of S Africa—Dec., 1902. No. 53593 E.

Wales.

Gold Mining in Wales. W. H. Booth. An illustrated review of Welsh gold mining, the methods used for the extraction of the gold, history of the various mines, their equipment, and matters of related interest. 5600 w. Cassier's Mag—Feb., 1903. No. 53828 B.

Witwatersrand.

The Equipment of the Bonanza Mine, Johannesburg. Edgar Smart. The first of a series of illustrated articles dealing with the gold-mining plants of the Rand. Especially noticing the points in which plants differ, and improvements in detail of plant or practice. 4000 w. Page's Mag—Feb., 1903. No. 53833 B.

IRON AND STEEL.

Blowing Engines.

See Mechanical Engineering, Steam Engineering.

Cast Steel.

Blow Hole and Pipe Formations in Cast Steel. H. Diederichs. An illustrated review of a paper by A. Von Dormus, describing methods used by the steel works at St. Etienne, and the work of J. A. Brinell. 1400 w. Sib Jour of Mech Engng—Jan., 1903. No. 53661 C.

Desulphurizing.

Manganese Ore as a Desulphurizing Agent in Basic Open Hearth Practice. A. Riemer, in *Stahl und Eisen*. Gives results of experiments showing the influence of manganese ore and its value as a desulphurizing agent, and giving related facts and tests of importance. 1600 w. Ir Age—Jan. 29, 1903. No. 53304.

Electric Driving.

See Electric Engng. Power Applications.

Fuel.

The Use of Sulphur-Bearing Fuel in the Blast Furnace (Ueber die Verwendung Schwefelreicher Brenstoffe im Hochofen). Oskar Simmersbach. With tables showing the influence of sulphur in the fuel upon the iron for various ores. 1500 w. Stahl u Eisen—Feb. 1, 1903. No. 53761 D.

Furnace Gas.

See Mechanical Engng. Power and Transmission.

Iron Ore.

An Ontario Iron Ore Deposit. Two articles giving information in regard to the deposits of the Hutton Iron Range. 2200 w. Eng & Min Jour—Jan. 31, 1903. No. 53439.

Lake Superior.

The Iron Ore Trade of the Lake Superior Region for the Year 1902. Horace J. Stevens. Reports the largest output ever made in one year. 2800 w. Mines & Min —Feb., 1903. No. 53522 C.

Metallography.

General Method for the Micrographic Analysis of Steel. F. Osmond. Translated from the French. Gives a full description of methods from the preparation of samples, a study of the constituents, and detailed examination of a few steels with illustrations. 13000 w. Pro Engrs' Soc of W Penn—Dec., 1902. No. 53666 D.

New Micrographic Constituents Upon the Surface of Hardened Steel (Neue Mikrographische Gefügedestandteile auf der Oberflache des Gehärtelen Stahls). W. Ischewsky. With reproductions of microphotographs showing the structure of various hardened steels. 1200 w. 1 plate. Stahl u Eisen—Jan. 15, 1903. No. 53760 D.

The Use of the Microscope in the Determination of the Properties of Steel. Prof. Albert Sauveur. An illustrated article showing the value of the science of metallography, especially considering iron and steel. Also discussion, and paper by W. J. Beck on "The Preparation of Samples for Microscopic Analysis, etc." 9900 w. Pro Engrs' Soc of W Penn—Dec., 1902. No. 53665 D.

Minnesota.

The Vermillion Iron Range in Minnesota. D. E. Woodbridge. A brief account of the exploration in progress. 900 w. Eng & Min Jour—Feb. 14, 1903. No. 53631.

Steel Castings.

The Manufacture and Applications of Steel Castings (Stahlformguss und Seine Verwendung). Bernhard Osann. A discussion of the present state of the art of making steel castings in the light of the exhibits at the Düsseldorf exposition. Stahl u Eisen—Jan. 15, 1903. No. 53759 D.

Steel Ingots.

Classifying Steel Ingots, and the Influence of Chemical Composition on Their Solidity. From *Stahl und Eisen.* An illustrated article describing various types of ingot and giving the classification made by J. A. Brinell. 1500 w. Ir Age—Feb. 19, 1903. No. 53624.

Steel Works.

See Mechanical Engineering, Machine Works and Foundries.

Tin Plate.

The Manufacture of Tin Plate. B. E. V. Luty. Read before Calvary Church Brotherhood, Pittsburg. A review of the processes used in this industry, describing the manufacture. 3600 w. Met Work—Feb. 14, 1903. No. 53533.

Tool Steel.

See Mechanical Engineering, Materials.

Utah.

Notes on Southwestern Utah and Its Iron Ores. G. C. Hewitt. Read before the Colorado Sci. Soc. Describes this interesting region, giving details and impressions obtained during recent visits. 3300 w. Min Rept—Feb. 12, 1903. No. 53633.

MINING.

Analysis.

Modern Methods of Rock and Mineral Analysis. Dr. W. F. Hillebrand. An outline of present practice, showing why it differs from earlier times. 5800 w. Jour Fr Inst—Feb., 1903. Serial. 1st part. No. 53573 D.

Deep Mining.

Deep Mining Will Bring Success—Something About Geological Formations in New Mexico. C. H. Laidlaw. A study of the geology, giving reasons for believing valuable minerals may be found at great depths. 1000 w. Min Rept—Feb. 5, 1903. No. 53497.

Electric Hoisting.

See Electrical Engineering, Power Applications.

Electric Pumping.

See Electrical Engineering, Power Applications.

Explosion.

The Abertysswg Colliery Explosion. Reported by Mr. S. T. Evans and J. S. Martin on the circumstances attending this explosion, which occurred at Mac Laren Colliery, Sept. 3, 1902. 8500 w. Col Guard—Jan. 30, 1903. Serial. 2 parts. No. 53557 each A.

The Gas Explosion at the Doblhoff Shaft at Modlan (Die Brandgas Explosion auf dem Doblhoff III Schachte in Modlan). Adolf Hummel. A detailed account of the disastrous mine explosion at Modlan, near Brüx, Bohemia, on April 30, 1902. Serial, Part I. 2000 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—Feb. 7, 1903. No. 53749 D.

Explosives.

The Protection of Explosive Magazines from Lightning. Notes embodying the recommendations of an official commission appointed in Belgium to consider the best means of protection. 2000 w. Col Guard —Feb. 6, 1903. No. 53611 A.

We supply copies of these articles. See page 157.

The Theory of Misfires and Some Conclusions of Practical Value. Continued discussion of paper by E. H. Weiskopf. 1700 w. Jour Chem & Met Soc of S Africa—Dec., 1902. No. 53591 E.

Hoisting.

The Installation of a Cable for a Koepe Hoisting Plant (Das Auflegen der Seile bei Koepe Fördermaschinen). K. I. Müller. Describing the method of drawing a new cable through the sheaves and drums of a double mine hoist by means of a temporary auxiliary cable and winding drum. 1000 w. Glückauf—Jan. 17, 1903. No. 53742 B.

Mexico.

Notes on a Section Across the Sierra Madre Occidental of Chihuahua and Sinaloa, Mexico. Walter Harvey Weed. Diagrammatic section, with notes on the geological features. 6000 w. Trans Am Inst of Min Engrs—Nov., 1901. No. 53335 D.

The District of Hidalgo Del Parral in 1820. Norberto Dominguez. History of this mining region, abstracted from the report of a commission appointed to investigate the conditions. 7200 w. Trans Am Inst of Min Engrs—Nov. 1902. No. 53347 C.

Mining Management.

The General Management of Metalliferous Mines. Albert Williams, Jr. The concluding article of the series discusses the methods of increasing the efficiency of the management staff by a suitable division of duties. 3500 w. Engineering Magazine—March, 1903. No. 53793 B.

New Mexico.

The Ore-Deposits of the San Pedro District, New Mexico. Morrison B. Yung, and Richard S. McCaffery. Maps and illustrations showing the general geology of the region, with description of the deposits of copper lead-silver and gold. 3500 w. Trans Am Inst of Min Engrs—Oct., 1902. No. 53345 C.

Ore Deposits.

A Consideration of Igneous Rocks and Their Segregation or Differentiation as Related to the Occurrence of Ores. J. E. Spurr. A study of principles involving the connection of igneous rocks with ore deposition. 18800 w. Trans Am Inst of Min Engrs—Feb. & May, 1902. No. 53333 D.

Igneous Rocks and Circulating Waters as Factors in Ore-Deposition. J. F. Kemp. Discusses the views of Prof. Van Hise and other writers, and gives reasons for differing in some of the conclusions, especially in regard to deep mines. 6000 w. Trans Am Inst of Min Engrs—Oct., 1902. No. 53344 C.

The Genetic Classification of Ore-Bodies. Gives a classification proposed by W. H. Weal, and report of the discussion. 4800 w. Eng & Min Jour—Feb. 14, 1903. No. 53630.

The Sierra Mojada, Coahuila, Mexico, and its Ore Deposits. S. F. Emmons. A contribution of the discussion of the paper of James W. Malcolmson. 800 w. Trans Am Inst of Min Engrs—Nov., 1901. No. 53339.

Pit Heads.

The Bentrop System of Airtight Pit Head Casings. Illustrated detailed description of this type of construction, with particulars of its operation. 3300 w. Ir & Coal Trds Rev—Jan. 23, 1903. No. 53465 A.

Sampling.

The Sampling and Estimation of Ore in a Mine. T. A. Rickard. The first of a series of articles giving details of personal practice, and containing valuable information. Ill. 3000 w. Eng & Min Jour—Feb. 7, 1903. Serial, 1st part. No. 53505.

Shaft Sinking.

Shaft-Sinking Through Water-Bearing Strata. Indicates various methods that have been adopted or proposed for dealing with exceptional quantities of water under difficult circumstances. 5000 w. Ill. Col Guard—Jan. 30, 1903. No. 53556 A.

The Deepening of Two Ventilating Shafts of the Bruch, Bohemia, Coal Mines (Ueber das Abteufen zweier Wetterschachte in Brucher Grubenfelde). A. Padour. A description of the method employed in deepening two ventilating shafts without interruption of the air flow, with log of the progress of the work. Three articles, 2 plates. 4000 w. Oesterr Zeitschr f Berg u Hüttenwesen—Jan. 17, 24, 31, 1903. No. 53748 each D.

Shot Firing.

The Management of Shot-Firing in Coal Mines. Suggests rules which, if enforced, the writer believes would reduce accidents from this cause to a minimum. 2000 w. Col Guard—Feb. 6, 1903. No. 53612 A.

Timber.

The Utilization of Pit Tips for the Growing of Pit Timber. Abstract of a paper by Mr. Herbert Stone before the So. Staffordshire Iron & Steel Inst. Showing that trees can be grown on these pit mounds to advantage. 3500 w. Col Guard—Jan. 23, 1903. No. 53459 A.

Valuation.

Examination and Valuation of Mines. Prof. Arthur Lakes. Discusses the use of the term "ore in sight," the difference between a "mine" and a "prospect," and other matters. Also editorial. 5800 w. Mines & Min—Feb., 1903. No. 53521 C.

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MISCELLANY.

Borax.

American Borax Mines. Don Maguire. An account of the discovery of this mineral in the deserts of California and Nevada, and the methods of transporting and preparing it. 3800 w. Mines & Min—Feb., 1903. No. 53519 C.

Fluor Spar.

The Fluor Spar and Zinc Mines of Kentucky and Illinois. F. H. Harwood. Begins an illustrated detailed account of the mines of this district. 1000 w. Min & Sci Pr—Feb. 7, 1903. Serial, 1st part. No. 53575.

Lead.

Lead Refining in Trail, B. C. An illustrated description of a refinery using the Betts Electrolytic process. 1300 w. Can Min Rev—Jan. 31, 1903. No. 53385 B.

Petroleum.

Principles controlling the Geologic Deposition of the Hydrocarbons. George I. Adams. Also discussion by David T. Day. A discussion dealing more particularly with deposits of gas and oil which have resulted from underground circulation. 4000 w. Trans Am Inst of Min Engrs—Feb. & May, 1902. No. 53342 C.

The Boulder Oil-Field, Colorado. J. E. Kirkbride. A brief account of this district, the wells, the yield, etc. 900 w. Eng & Min Jour—Feb. 7, 1903. No. 53508.

Salt.

Evaporated Salt Industry in Kansas. W. R. Crane. An illustrated article describing the works where salt is made from brines, reporting concerning the output, value, methods, etc. 3000 w. Eng & Min Jour—Feb. 7, 1903. No. 53514.

Tin.

The Pioneer Tin Mine (T.). Illustration, with description of the deposits of north-east Tasmania. 3000 w. Aust Min Stand—Jan. 1, 1903. Serial, 1st part. No. 53599 B.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

Accidents.

Train Accidents in the United States in December. Condensed record of the principal accidents, with editorial comments on the more serious. 4000 w. R R Gaz—Feb. 13, 1903. No. 53546.

Automatic Control.

Automatic Electrically Controlled Engines. George E. Walsh. Brief description of automatic train controlling systems which seem promising. 1500 w. Elec Rev, N Y—Feb. 7, 1903. No. 53490.

Braking.

Braking and Traction Brakes. Charles F. Scott. Introductory remarks to a series of papers on this subject. 800 w. Trans Am Inst of Elec Engrs—Jan., 1903. No. 53667 D.

Railroad-Car Braking. R. A. Parke. A sketch of the practical development of brakes in railroad service; an analysis of the results of investigations of brake-shoe friction; brake efficiency, etc. The peculiar characteristics of the magnetic brake are also briefly described. Ill. and discussion. 26,000 w. Trans Am Inst of Elec Engrs—Jan., 1903. No. 53669 D.

Some Brake-Tests and Deductions Therefrom. J. D. Keiley. A description of a method of making brake-tests, and of a recording apparatus used in this method; also results from tests on varieties of brakes, and an empirical equation showing the operation of these brakes under different conditions. Ill. 2800 w. Trans Am Inst of Elec Engrs—Jan., 1903. No. 53668 D.

Collision.

The Westfield Collision. An editorial discussion of means of preventing rear collisions, and some particulars in regard to the accident. 5000 w. R R Gaz—Feb. 6, 1903. No. 53424.

Fuel.

Economical Use and Accounting Methods for Handling Fuel for Locomotives. F. A. Healy. Read before the Southern & Southwestern Ry. Club. Considers mainly the accounting and its difficulties. 2800 w. Ry Age—Feb. 6, 1903. No. 53499.

MOTIVE POWER & EQUIPMENT.

Cars.

A Quarter of a Century of Car Building. States some of the conditions existing twenty-five years ago, reviewing the development of the freight car. 5400 w. Ry Mas Mech—Feb., 1903. No. 53802.

Development of the Railroad Car. Eugene Chamberlin. Recalls the peculiarities of early freight and passenger cars, and the improvements introduced. 1200 w. Loc Engng—Feb., 1903. No. 53403 C.

Is the 10-Ton Wagon the Best After All. Compares British and American practice, and considers the 10-ton type the most suitable for the traffic in England. Also discusses other matters affecting the

We supply copies of these articles. See page 157.

cost of haulage. 2800 w. Ir & Coal Trds Rev—Feb. 13, 1903. No. 53699 A.

New Dining and Parlor Café Cars, Baltimore & Ohio R. R. Exterior and interior views, floor plans and description. 1200 w. Ry & Engng Rev—Feb. 21, 1903. No. 53840.

Car Lighting.

Car Lighting. E. G. Fisher. Describes the acetone-acetylene storage system. 2500 w. Ry & Engng Rev—Feb. 14, 1903. No. 53634.

Railway Carriage Lighting by Electricity: J. Stone & Co.'s System. J. H. Dowling. Read before the Dublin Local Soc. of the Inst. of Elec Engrs. Illustrated detailed description. 3000 w. Elec Engr, Lond—Jan 23, 1903. No. 53475 A.

Symposium on Car Lighting. Extracts from papers read before the New England Railroad Club, considering the various systems of lighting cars. 8500 w. Ry Age—Feb. 20, 1903. No. 53807.

The Present Status of the Art of Illumination, with Reference to Train-Lighting (Der Heutige Stand der Beleuchtungswesen mit Berücksichtigung der Beleuchtung der Eisenbahnwagen). Dr. W. Wedding. A general discussion of the technics of artificial lighting, presented before the German Railway Association. 3000 w. Glasers Annalen—Feb. 1, 1903. No. 53730 D.

Car Truck.

The Flexible Car Truck. Charles S. Shallenberger. Discusses the evils of various forms of trucks and methods of remedying them, suggesting the introduction in car truck construction of spring-bearing column guide plates, giving longitudinal flexibility for the absorption of shock. Ill. 2500 w. St. Louis Ry Club—Jan. 9, 1903. No. 53373.

Draft Gear.

The Friction Draft Gear Problem. R. A. Parke. Extracts from a paper read before the New England Ry. Club. Discusses this subject, showing how difficult is the problem. 2200 w. R R Gaz—Feb. 13, 1903. No. 53544.

High Speed.

Prize Announcement (Preisausschreiben). Record of the meeting of the Verein Deutscher Maschinen-Ingenieure for the award of prizes for high speed express steam locomotives for passenger service; with discussion of the awards. 2500 w. Glasers Annalen—Feb. 1, 1903. No. 53731 D.

Locomotive Appliances.

Locomotive Draft and Spark Arrester Appliances. J. E. Muhlfeld. States the advantageous features claimed for this device, discussing criticisms. Ill. 2000 w. Ry Age—Feb. 13 1903. No. 53579.

Locomotives.

Atlantic-Type Locomotive for the Norfolk & Western. Illustrated general description of high-speed engines. 500 w. R R Gaz—Feb. 6, 1903. No. 53425.

Chicago & Alton "Pacific" Locomotive. Illustrated description of engines built for passenger service between Chicago and St. Louis. 900 w. Ry Age—Feb. 20, 1903. No. 53806.

"Decapod" Passenger Locomotive for the Great Eastern Railway. Illustrates and describes an engine of exceptional power possessing features of interest. 1200 w. Engng—Jan. 23, 1903. No. 53453 A.

Midland Railway Three-Cylinder Compound Passenger Locomotives. Two-page engraving and full illustrated description of this new type engine for the heaviest express traffic, with indicator diagrams, and report of trials, experiments, etc. 3300 w. Engng—Feb. 6, 1903. No. 53613 A.

New Freight Locomotive for the "Burlington." Illustrated description of a heavy locomotive of the 2-8-0 type. 300 w. Am Engr & R R Jour—Feb., 1903. No. 53427 C.

Norfolk & Western Atlantic Locomotive. Illustrated detailed description of an engine expected to run at rather high speed. 400 w. Ry Age—Feb. 13, 1903. No. 53578.

Passenger Locomotive—Northern Pacific Railway. Illustration, general dimensions and description of an engine of the 4-6-2 type. 500 w. Am Engr & R R Jour—Feb., 1903. No. 53431 C.

Suburban Locomotive, Great Eastern Railway. Explains the reasons for this enormous locomotive, and gives illustrated detailed description of this machine which is a great departure from normal railway practice in Great Britain. 2000 w. Engr, Lond—Feb. 6, 1903. No. 53618 A.

Ten Wheel Coupled Locomotives in South Africa. Illustration, with brief description of the largest and most powerful engines yet used on so narrow a gauge, 3 ft. 6 in. 600 w. Engr, Lond—Feb. 13, 1903. No. 53698 A.

The Comparison of Locomotives. Lawford H. Fry. An extension of the analysis of the "B D" method to cover compound locomotives. 2000 w. Am Engr & R R Jour—Feb., 1903. No. 53429 C.

Twenty-five Years of Locomotive Development. A brief review of locomotive practice in 1878, and the improvements introduced since that date. 4000 w. Ry Mas Mech—Feb., 1903. No. 53801.

Private Car.

Private Car "Brunswick," Brunswick & Birmingham R. R.. Exterior and interior views, with floor plan and descriptive notes. 700 w. Ry & Engng Rev—Jan. 31, 1903. No. 53392.

We supply copies of these articles. See page 157.

Supply Car.

The Railway Supply Car. J. P. Murphy. Discusses the distribution of supplies with a regularly assigned car, and the merits of the system, giving an illustrated description of an arrangement found practicable. Discussion. 10800 w. Pro W Ry Club—Jan. 20, 1903. No. 53568 C.

Wheels.

Cast-Iron Wheels to Meet To-day's Requirements. Papers by F. W. Sargent, Pemberton Smith and W. J. Taylor, with discussion. 11700 w. N Y R R Club—Jan. 16, 1903. No. 53648.

The Chilled Iron Car Wheel. C. V. Slocum. Brief paper on the strength and durability of these wheels and the demands made on them, followed by discussion. 7300 w. Ry Club of Pittsburgh—Nov., 1902. No. 53649 C.

NEW PROJECTS.

Africa.

South African Railways. Editorial review of the new railway work about to be undertaken and the development of the lines already constructed. 1700 w. Engng—Jan. 23, 1903. No. 53455 A.

Ecuador.

Some Features of the Guayaquil and Quito Railway, Ecuador. William D. Beatty. An illustrated article describing the construction of this railway in equatorial regions, the country, labor available, etc. 4000 w. Pro Engrs' Club of Phila—Jan., 1901. No. 53674 D.

Improvements.

L. B. and S. C. Railway Improvements. A descriptive and illustrated account of some of the more important works being carried out on the London, Brighton, and South Coast Railway, viaducts, bridges, etc. 1500 w. Engr, Lond—Jan. 23, 1903. Serial. 1st part. No. 53463 A.

Nicaragua.

The Central Railway of Nicaragua. Emil Mueller. Map with brief description of the new division connecting the previously built railways, thus making a continuous line from Corinto, on the Pacific, to Granada, on Lake Nicaragua. 700 w. Eng News—Feb. 12, 1903. No. 53536.

PERMANENT WAY & FIXTURES.

Grades.

Virtual Grades for Freight Trains. Continued discussion of paper by A. C. Dennis. Plate 1700 w. Pro Am Soc of Civ Engrs—Jan., 1903. No. 53353 E.

Rails.

Notes on Girder Rail Design. Selwyn Grant. A discussion of grooved rails of the ordinary pattern, giving illustrations, and such information as is needed in making a choice. 3000 w. Tram & Ry Wld—Feb. 12, 1903. No. 53687 B.

Road Bed.

The Standard Road Bed of the Swiss Government Railways (Die Oberbau Normalien der Schweizerischen Bundesbahnen). Giving the standard rail sections and also full details of the standard metallic cross ties. 2000 w. Schweiz Bauzeitung—Jan. 31, 1903. No. 53755 B.

Roundhouse.

New Roundhouse of the New York Central at Rensselaer. Illustrates and describes a new passenger engine roundhouse and its attendant facilities. 2400 w. R R Gaz—Feb. 20, 1903. No. 53652.

The New Roundhouse at Rensselaer. Illustrates and describes a roundhouse of the New York Central & Hudson River Railroad, and its equipment. 700 w. Am Engr & R R Jour—Feb., 1903. No. 53428 C.

Shops.

A Modern Car Shop. W. E. Sharp. An illustrated article describing the arrangement considered best suited to give large output at the lowest cost, the operation, etc. Discussion follows. 4000 w. Pro W Ry Club—Jan. 20, 1903. No. 53569 C.

Pocatello Shops of the Oregon Short Line. Illustrates and describes details of this enlarged shop plant in Idaho. 2000 w. Ry & Engng Rev—Feb. 7, 1903. No. 53500.

Railway Shops. R. H. Soule. The first of a series of articles on modern railroad shops and their problems. 1400 w. Am Engr & R R Jour—Feb., 1903. Serial. 1st part. No. 53430 C.

Signals.

An Official Recommendation of Automatic Stops in Connection with Block Signals. Extract from report of the Illinois R. R. & Warehouse Commission in which F. G. Ewald strongly favors automatic brake-setting devices. Ill. 2500 w. Eng News—Feb. 19, 1903. No. 53657.

Development of Railway Signalling in the Last Twenty-five Years. A review of the development in block signalling, and interlockings. Ill. 4500 w. Ry Mas Mech—Feb., 1903. No. 53803.

Telephones in Engine Cabs. Describes the nature and operation of a new safety device for railroads, which has been tested in Germany. 600 w. Sci Am Sup—Feb. 21, 1903. No. 53824.

I. The Miller Automatic Railway Signals. II. Fixed Signals on Line Side v. Signals Carried on Locomotives. III. Editorial. Three articles dealing with the Miller system of automatic railway signalling. 5700 w. Elec Rev, Lond—Feb. 13, 1903. No. 53689 A.

We supply copies of these articles. See page 157.

Switches.

The Computation of Turnouts (Die Berechnung von Muttergeleisen). Max Fischl. A discussion of the construction of railway switches and turnouts, including the computation of the curves, and the arrangement of cross ties and fastenings. 3000 w. Zeitschr d Oesterr Ing u Arch Ver—Feb. 6, 1903. No. 53726 B.

Tracks.

Progress in Track Construction During the Past Quarter of a Century. Considers the subject in detail. 2400 w. Ry Mas Mech—Feb., 1903. No. 53804.

Wear.

Wheel Flange and Rail Wear. H. M. Perry. Discusses the cause and thinks the remedy is in finding a suitable anti-friction side bearing which will allow the truck to swing freely within proper limits and to have sufficient bearing surface to support any load it may be called upon to carry. 700 w. R R Gaz—Feb 6, 1903. No. 53423.

TRAFFIC.

Freight.

Average Lading of Freight Cars and Tons Lading of Freight Trains. J. H. McPartland. Suggestions for the loading of cars that will accomplish a saving. Followed by general discussion. 8800 w. Pro W Ry Club—Jan. 20, 1903. No. 53567 C.

Overland Transport.

American Overland Transport to the Orient. H. Emerson. A discussion of the development of Pacific Coast commerce in connection with the transcontinental railways; considering the pending reversal of the commerce route now existing through the Suez Canal. 4000 w. Engineering Magazine—March, 1903. No. 53791 B.

STREET AND ELECTRIC RAILWAYS

Alternating Current.

Equipment of Railways with Converter Sub-Stations. Alton D. Adams. Reviews the various plans for generating alternating currents for a railway that extends beyond the limits of a single power station, describing the types of equipment, methods, etc. 3000 w. St Ry Rev—Feb. 20, 1903. No. 53821 C.

Berlin.

The Electric Driving of the Great Berlin Street Railway (Der Elektrische Betrieb auf der Grossen Berliner Strassen). A general description of the electrical operation of the surface tramways of Berlin. 4000 w. Elektrotech Zeitschr—Jan. 29, 1903. No. 53769 B.

Bolton.

The Tramway System of Bolton. Map and full illustrated account of this English tramway which has features of construction of interest. Also gives an outline of its history. 7000 w. Tram & Ry Wld—Jan. 15, 1903. No. 53324 B.

Brooklyn.

Improved Power Facilities for the Brooklyn Rapid Transit Company. Plans and interior views of four of the principal sub-stations are given, with descriptive notes. 3000 w. St Ry Jour—Feb. 14, 1903. No. 53580 D.

Cars.

Standard Car in Denver. Brief illustrated description of a car differing materially from that of any other city, but very popular. It is both a combination and semi-convertible car. 3500 w. St Ry Jour—Feb. 7, 1903. No. 53496 D.

Cleveland Trolleys.

The Trolley Situation in Cleveland. A study of the conditions of local short-haul and long-haul electric traffic. 3300 w. R R Gaz—Feb. 6, 1903. No. 53422.

Combined System.

Combined Conduit and Overhead System at Bournemouth. A. N. Connett. An illustrated detailed description of this combined conduit and overhead construction and the arrangement for changing the car from the one to the other. The conduit under one track rail was adopted. 3000 w. Tram & Ry Wld—Jan. 15, 1903. No. 53323 B.

Conversion

Steam Railroad Converted to Electric System. Illustrates and describes the changes made in the Cincinnati, Georgetown & Portsmouth Railroad. 5000 w. St Ry Jour—Feb. 21, 1903. No. 53826 D.

Electric Locomotive.

A 10,000-Volt High-Speed Electric Locomotive. An illustrated detailed description of the improved design worked out by Herr Reichel. 4000 w. Feilden's Mag—Feb., 1903. No. 53832 B.

Electric Railway Working.

An Arrangement of Power Stations for Operating Steam Railways Electrically. C. J. Spencer. Discusses the applying of electric traction to a steam railroad. Also editorial. 3000 w. Elec Wld & Engr—Feb. 14, 1903. No. 53587.

France.

Electric Road from Fayet to Chamonix. Illustrated detailed description of a road leading to this French village near Mont

We supply copies of these articles. See page 157.

Blanc, which is a popular tourist resort. It possesses features of interest. Also describes rolling stock, and notes proposed extensions. 4000 w. St Ry Jour—Feb. 7, 1903. No. 53494 D.

Germany.

The Street Railways of Germany (Die Strassenbahnen Deutschlands). A. Liebmann. A critical analysis of the statistics of German street railways, with diagrams showing the relations of the various elements of operation to the number of passengers. 4000 w. Ill. Zeitschr f Klein u Strassenbahnen—Jan. 16, 1903. No. 53789 D.

Goods Traffic.

Freight and Express on Electric Railways. H. S. Cooper. The first of a series of articles discussing the handling of freight and express by electric roads, the charges, classification, etc. 3500 w. St Ry Jour—Feb. 7, 1903. Serial. 1st part. No. 53495 D.

High Speed.

High Speed Electric Traction (Essais de Traction Electrique à Grande Vitesse). F. Drouin. An illustrated account of the trials of high-speed trains between Berlin and Zossen. Two articles, 2 plates. 5000 w. Génie Civil—Jan. 10, 17, 1903. No. 53713 each D.

Interurban.

Terminal Station and Freight-Handling System for Interurban Electric Railways at Cincinnati, O. Illustrated description of a station for the accommodation of passenger and freight traffic, now under construction. 1500 w. Eng News—Jan. 29, 1903. No. 53311.

Lancaster.

Lancaster Electric Tramways. Illustrated description of the routes completed, the equipment, power, etc., of the Lancaster, England, tramways. 1600 w. Tram & Ry Wld—Feb. 12, 1903. No. 53686 B.

London.

The District Railway and Its Associated Lines. A view of the present situation with map of the lines and drawings of the cars being built for experimental trial. Also an important speech delivered by Mr. Perks to the shareholders. 8000 w. Tram & Ry Wld—Jan. 15, 1903. No. 53325 B.

Overcrowding.

The Overcrowding of Street Cars. Dr. Louis Bell. Discusses some of the causes and what can be done to remedy them. 2000 w. Elec Rev, N Y—Feb., 14, 1903. No. 53581.

Paving.

The Paving of Permanent Ways for Tramways and Light Railways. From the *Railway Engineer*. Gives the laws of England in regard to the requirements, and the kinds of paving used. Discusses the mineral composition of some paving stones, wear, etc. 4500 w. Quarry—Feb. 1, 1903. No. 53605 A.

Returns.

Returns from Electrified Steam Railroads. Editorial discussion of the returns from the lines of the New York, New Haven & Hartford. 1500 w. R R Gaz—Feb. 13, 1903. No. 53547.

South Carolina.

Columbia Electric Street Railway, Light & Power Co., of Columbia, S. C. An illustrated detailed description of the construction, distribution, equipment, and other features. 4000 w. St Ry Rev—Feb. 20, 1903. No. 53818 C.

Trolley.

Railless Electric Trolley System. Enrico Bignami. Illustrated description of system used by Siemens & Halske, of Berlin. 1000 w. Elec Rev, N Y—Jan. 31, 1903. No. 53400.

Trolley Wires.

The Suspension of Trolley Wires (Die Aufhangung des Fahrdrahtes Elektrischer Bahnen). F. Hermann. A discussion of the stresses in overhead trolley wires, taking into account the weight of the wire and the effect of temperature changes. 3000 w. Ill Zeitschr f Klein u Strassenbahnen—Feb. 1, 1903. No. 53790 D.

Valtelline.

The Operation of the Valtelline Railway by High Tension Polyphase Currents (Der Betrieb der Valtellina-Bahn mit Hochgespanntem Drehstrom). E. Cserhati & K. von Kando. A very complete account of the Valtelline electric railway, in which the Ganz polyphase system is used. Serial, Part I. 3000 w. Zeitschr d Ver Deutschr Ing—Feb. 7, 1903. No. 53710 D.

Valtellina High-Tension Three-Phase Railway. An interesting account of this line which is exciting much interest, as it is testing the application of electricity to the conditions of steam roads, and may lead to the conversion to electric traction of all roads of Northern Italy. Ill. 3000 w. Engr, Lond—Jan. 30, 1903. Serial. 1st part. No. 53561 A.

Vienna.

The Metropolitan Railway of Vienna (Le Chemin de Fer Métropolitain de Vienne). René Philippe. An illustrated description of the overhead, surface, and underground municipal railway of Vienna. Two articles, 1 plate. 5000 w. Génie Civil—Jan. 31, Feb. 7, 1903. No. 53717 each D.

We supply copies of these articles. See page 157.

EXPLANATORY NOTE—THE ENGINEERING INDEX.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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Each coupon will be received by us in payment for any 20-cent article catalogued in the Index. For articles of a higher price, one of these coupons will be received for each 20 cents; thus, a 40-cent article will require two coupons; a 60-cent article, three coupons; and so on. The use of these coupons is strongly commended to our readers. They not only reduce the cost of articles 25 per cent. (from 20c. to 15c.), but they need only a trial to demonstrate their very great convenience—especially to engineers in foreign countries, or away from libraries and technical club facilities.

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CARD INDEX.—These pages are issued separately from the Magazine, printed on one side of the paper only, and in this form they meet the exact requirements of those who desire to clip the items for card-index purposes. Thus printed they are supplied to regular subscribers of THE ENGINEERING MAGAZINE at 10 cts. per month, or $1.00 a year; to non-subscribers, 25 cts. per month, or $3.00 a year.

THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* Boston.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Jl. of Science. *m.* New Haven, U.S.A.
American Machinist. *w.* New York.
American Shipbuilder. *w.* New York.
American Telephone Journal. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. d Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *qr.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Sydney.
Autocar. *w.* Coventry, England.
Automobile. *m.* New York.
Automobile Magazine. *m.* New York.
Automotor & Horseless Vehicle Jl. *m.* London.
Beton und Eisen. *qr.* Vienna.
Brick Builder. *m.* Boston.
British Architect. *w.* London.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bulletin American Iron and Steel Asso. *w.* Philadelphia, U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. Soc. Int. d Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Montreal.
Canadian Mining Review. *m.* Ottawa.
Cassier's Magazine. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Electrical Engineer. *w.* London.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Electrochemical Industry. *m.* Philadelphia.
Electrochemist & Metallurgist. *m.* London.

Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Cleveland, U. S. A.
Engineering. *w.* London.
Enginering and Mining Journal. *w.* New York.
Enginering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penna. *m.* Pittsburg, U.S.A.
Feilden's Magazine. *m.* London.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland, U. S. A.
Gas Engineers' Mag. *m.* Birmingham.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e. d. Str. Ferr. *w.* Rome.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Horseless Age. *w.* New York.
Ice and Refrigeration. *m.* New York.
Ill. Zeitschr. f. Klein u. Straussenbahnen. *s-m.* Berlin.
Indian and Eastern Engineer. *m.* Calcutta.
Ingeneria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron and Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. Am. Foundrymen's Assoc. *m.* New York.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Journal of Sanitary Institute. *qr.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery *b-m.* Fort Monroe, U.S.A.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U.S.A.
Locomotive. *m.* Hartford, U. S. A.
Locomotive Engineering. *m.* New York.
Machinery. *m.* London.
Machinery. *m.* New York.
Madrid Cientifico. *t-m.* Madrid.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Metallographist. *qr.* Boston.
Metal Worker. *w.* New York.
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* City of Mexico.
Minerva. *w.* Rome.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining Reporter. *w.* Denver, U. S. A.
Mitt. aus d Kgl Tech. Versuchsanst. Berlin.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Modern Machinery. *m.* Chicago.
Monatsschr. d Wurtt. Ver. f Baukunde. *m.* Stuttgart.
Moniteur Industriel. *w.* Paris.
Mouvement Maritime. *w.* Brussels.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *m.* New York.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Nineteenth Century. *m.* London.
North American Review. *m.* New York.
Oest. Wochenschr. f. d. Oeff Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg- & Hüttenwesen. *w.* Vienna.
Ores and Metals. *w.* Denver, U. S. A.
Page's Magazine. *m.* London.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Power Quarterly. New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Procedings Engineers' Club. *qr.* Philadelphia.
Pro. St. Louis R'Way Club. *m.* St. Louis, U. S. A
Progressive Age. *s-m.* New York.
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Digest. *w.* New York.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago
Review of Reviews. *m.* London & New York.
Revista d Obras. Pub. *w.* Madrid.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Gen. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Sanitary Plumber. *s-m.* New York.
Schiffbau. *s-m.* Berlin.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Stahl und Eisen. *s-m.* Düsseldorf.
Steam Engineering. *m.* New York.
Stevens' Institute Indicator. *qr.* Hoboken, U.S.A.
Stone. *m.* New York.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago.
Telephone Magazine. *m.* Chicago.
Tijds. v h Kljk. Inst. v Ing. *qr.* Hague.
Traction and Transmission. *m.* London.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining. Eng. New York.
Trans. Am. Soc. of Civil Eng. *m.* New York.
Trans. Am. Soc. of Heat & Ven. Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
Western Electrician. *w.* Chicago.
Wiener Bauindustrie Zeitung. *w.* Vienna.
Yacht. *w.* Paris.
Zeitschr. d. Mitteleurop. Motorwagen Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a S.
Zeitschr. f. Electrotechnik. *w.* Vienna.

CURRENT RECORD OF NEW BOOKS

NOTE—Our readers may order through us any book here mentioned, remitting the publisher's price as given in each notice. Checks, Drafts, and Post-Office Orders, home and foreign, should be made payable to THE ENGINEERING MAGAZINE.

Compressed Air.

Compressed Air Information, or a Cyclopedia Containing Practical Papers on the Production, Transmission and Use of Compressed Air. Edited by W. L. Saunders, M. Am. Soc. C. E. Size, 8¼ by 6½ in.; pp. 1175; illustrations, 498. Price, $5. New York: "Compressed Air."

The articles composing this book are reprints of the principal papers, editorials and notes which were published in *Compressed Air* during the first five years of its existence. They cover a wide range of subjects and are grouped under the three main headings of Production, Transmission and Use, the latter section occupying more than two-thirds of the volume. There are many articles on air compressors and methods of compressing air, including the hydraulic system of air compression, but the most extensive and probably the most interesting part of the book is that devoted to the multitudinous applications of compressed air, including pneumatic tools, painting, the sand blast, pneumatic locks for canals, car traction and hoisting, to mention only a few. There is a list of United States patents relating to compressed air and its applications, and an index, and altogether this volume is, as its title well indicates, a compressed-air cyclopedia.

Drawing.

A Manual of Drawing. By C. E. Coolidge, Assistant Professor of Machine Design, Sibley College, Cornell University. Size, 9 by 6 in.; pp. IV., 178; figures, 43. Price (paper) $1. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

The system that has been evolved and embodied in this book is intended to be the average of the drafting room systems which are in use in the United States at the present day. Part I of the manual is devoted to drawing materials and instruments, which are described in considerable detail. In part II, commercial mechanical drawing is taken up, the different types of drawings are discussed and the proper methods of executing them are shown. Special attention is given to "dimensions," and other practical details are well treated. Altogether, the book is a most useful one for students and will not be out of place in the professional drafting room.

Dynamo Design.

Design of Dynamos. By Silvanus P. Thompson, D. Sc., F. R. S. Size, 9¼ by 6 in.; pp. VI, 253; illustrations, 92; plates, 8. Price, 12s. 6d. ($3.50). New York: Spon & Chamberlain. London: E. & F. N. Spon, Ltd.

In his well-known treatise on Dynamo-Electric Machines, of which the seventh edition is soon to be issued, the author has treated the whole subject broadly, historically, theoretically and practically. The present shorter work is intended principally for students and for engineers who are acquainted with the theory of electricity and magnetism, but who have had no practical experience in the design of electric machinery, and its immediate end and aim, therefore, is to give such persons a working insight into the procedure of dynamo design as carried out in recent years for the construction of continuous-current dynamos of modern type. There are chapters on dynamo design as an art, magnetic calculations as applied to dynamo design; copper calculations and coil windings; insulating materials; armature winding schemes; estimation of losses, heating and pressure drop; the design of continuous-current dynamos; and examples of dynamo design. An appendix contains wire-gauge tables and schedules for the design of continuous-current dynamos, and there are plates with curves of magnetic data and designs of dynamos. The book is well made and printed, and an index completes a very useful and practical work.

Erie Railway.

Between the Ocean and the Lakes. The Story of Erie. By Edward Harold Mott. Size, 10 by 12 in.; pp. XII, 524. Price, $7.00 (30 shillings). New York: John S. Collins.

The history of the first railroad built in the United States for the avowed purpose of beginning the opening up of the great West would in itself be a work of essential importance in connection with the story of the development of the nation, but when the history is also that of the origin and development of the whole gigantic system of railway speculation and stock manipulation so essentially a portion of finance and investment in all parts of the world, it becomes doubly important. The story of

Erie is indirectly the history of the railroads of the United States, it includes striking and exciting incidents without precedent, it involves personal sacrifices and efforts of men prominent socially and financially, it evolves many of the ideas in the modern science of railroading, it is as startling and dramatic as any incidents which enliven the pages of fiction. It is not alone the history of a railroad, it is a history of men and measures and methods which for two generations were powerful in the social, financial, and commercial affairs of the United States and Europe. The narrative is not without its dark side, and in its pages are revealed details of dishonesty and crime which carry their lessons with them. In this difficult portion of the work, as in the entire volume, Mr. Mott has done his work well, and the laborious and tedious study of reports, newspapers, and old publications which he has conducted has preserved from oblivion facts of vital importance to the modern student of history, to the man who realizes that the true history of a people is found, not only in the records of its legislative bodies and on its battle fields, but also in the daily life of its people and in the conduct of its great industrial enterprises. The book is handsomely printed and copiously illustrated, and includes many portraits and fac-simile reproductions of documents otherwise most difficult of access.

Kinematics.

Kinematics of Machines: An Elementary Text-Book. By R. J. Durley, B. Sc., Ma. E. Size 0¼ by 6 in.; pp. VIII, 379; figures, 230. Price, $4. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

This work is intended as an introduction to the study of the dynamical and other problems occurring in connection with the theory of machines, and it is based on the author's lectures to students of engineering at McGill University, where he is professor of mechanical engineering. The book deals only with the kinematics of machines, and after an introduction, there are chapters on position, velocity and acceleration; plane mechanism containing only turning pairs; slider-crank chains; determination of velocity and acceleration in plane mechanism; alterations of mechanisms, and closure; constraint and velocity ratio in higher pairing involving plane motion; wheel-trains and mechanisms containing them, and cams; ratchet mechanisms and escapements; mechanisms involving non-rigid links; chains involving screw motion; spheric motion; and kinematic classification of mechanisms. There are graphical and analytical solutions of the various problems encountered, and in the majority of cases numerical examples have been worked out in order to indicate as clearly as possible the practical bearing and the scope of the methods employed. Besides being an excellent manual for engineering students, which is its primary purpose, this book will be of value and interest to all who are concerned with the design and construction of machinery.

Locomotives.

Locomotives: Simple, Compound and Electric. By H. C. Reagan. Fourth edition. Size, 7½ by 5 in.; pp. XIII, 578; illustrations, 303. Price, $2.50. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

Originally called "Locomotive Mechanism and Engineering," this book has grown with the times and enlarged its scope. Its author, a practical engineer, has written a practical treatise, and carefully describes the manner in which the locomotive is handled while in service. The illustrations go into great detail and are fully explained in the text, so that the construction and operation of the various parts of the locomotive can be clearly understood. To impress this understanding firmly on the mind, questions are asked and answered in a way which will be of most benefit to the locomotive engineer. The present fourth edition of this work, besides devoting considerable attention to the electric locomotive and its details, describes the latest improvements in locomotive practice, including the newest types of compound and single-expansion locomotives, fire-boxes and boilers. The subjects of liquid fuel and oil-burning engines are carefully considered, as are also piston-valve engines, track-sanding apparatus, valve-motion for compound locomotives, metallic packing, air pumps and various other matters. The book well fulfills its purpose of putting the reader in touch with the very latest and highest types of locomotive and their details.

BOOKS ANNOUNCED.

Small Yacht Construction and Rigging. By Linton Hope. Price, $3. New York: Forest and Stream Publishing Co.

Electricity as Applied to Mining. By Arnold Lupton, G. D. Aspinall Parr and Herbert Perkin. Price, $3.50, (10s. 6d.). New York: D. Van Nostrand Company. London: Crosby, Lockwood and Son.

Engineering for Land Drainage. By Charles G. Elliott, C. E. Price, $1.50. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

The Sea Coast: (1) Destruction, (2) Littoral Drift, (3) Protection. By W. H. Wheeler. Price, 10s. 6d. ($4.50). London, New York and Bombay: Longmans, Green, and Co.

NEWS SUPPLEMENT

The Engineering Magazine—April, 1903

Coming Society Meetings.

AIR-BRAKE ASSOCIATION. Sec.: F. M. Nellis, 174 Broadway, New York. Annual meeting, April 28, Colorado Springs.

AMERICAN BOILER MANUFACTURERS' ASSOCIATION. Sec.: J. D. Farasey, Cleveland. Next meeting July, at Chattanooga.

AMERICAN ELECTROCHEMICAL SOCIETY. Sec.: C. J. Reed, 929 Chestnut St., Philadelphia. Next meeting, April 16-18, New York.

AMERICAN FOUNDRYMEN'S ASSOCIATION. Sec.: Dr. Richard Moldenke, P. O. Box 432, New York. Convention June 9-11, Milwaukee.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS. Sec.: Ralph W. Pope, 95 Liberty St., New York. Annual convention, June 22-26, Niagara Falls. Regular meeting on fourth Friday of each month, 12 W. 31st St., New York. April 24: Papers on Central Station Development.

AMERICAN RAILWAY ASSOCIATION. Sec.: W. F. Allen, 24 Park Place, New York. Meeting, April 22, 1903, New York.

AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION. Sec.: J. W. Taylor, 667 Rookery, Chicago. Meeting, June 22, etc., Mackinac Island, Mich.

AMERICAN RAILWAY MECHANICAL AND ELECTRICAL ASSOCIATION. Sec.: Walter Mower, Detroit. First annual meeting, Sept. 1-4, Saratoga Springs, N. Y.

AMERICAN SOCIETY OF CIVIL ENGINEERS. Sec.: C. W. Hunt, 220 W. 57th St., New York. Regular meetings, first and third Wednesdays of each month. Annual convention, June 8, Asheville, N. C.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Sec.: Prof. F. R. Hutton, 12 W. 31st St., New York. Semi-annual meeting, June, at Saratoga.

AMERICAN STREET RAILWAY ASSOCIATION. Sec.: T. C. Penington, 2020 State St., Chicago. Annual meeting, Sept. 2-4, Saratoga Springs, N. Y.

AMERICAN WATER-WORKS ASSOCIATION. Sec.: J. M. Diven, Elmira, N. Y. Annual meeting, June 23-26, Detroit.

ASSSOCIATION OF RAILWAY SUPERINTENDENTS OF BRIDGES AND BUILDINGS. Sec.: S. F. Paterson, Concord, N. H. Annual convention, Oct. 20, Quebec.

ASSOCIATION OF RAILWAY TELEGRAPH SUPERINTENDENTS. Sec.: P. W. Drew, Milwaukee. Next meeting, May 13-15, New Orleans.

BOSTON SOCIETY OF CIVIL ENGINEERS. Sec.: S. E. Tinkham, 715 Tremont Temple. Regular meetings on third Wednesday of each month, except January, when on fourth Wednesday.

CANADIAN RAILWAY CLUB. Sec.: W. H. Rosevear, Jr., Montreal. Regular meetings on first Tuesday of each month.

CANADIAN SOCIETY OF CIVIL ENGINEERS. Sec.: Prof. C. H. McLeod, 877 Dorchester St., Montreal. Regular meetings every alternate Thursday.

CENTRAL RAILWAY CLUB. Sec.: Harry D. Vought, 62 Liberty St., New York. Regular meetings on second Fridays of Jan., March, May, Sept. and Nov., Hotel Iroquois, Buffalo.

CHICAGO ELECTRICAL ASSOCIATION. Sec.: W. J. Warder, Jr., 900 Warren Ave. Regular meetings on first Friday of each month.

CIVIL ENGINEERS' CLUB OF CLEVELAND. Sec.: Arthur A. Skeels, 689 The Arcade. Regular meetings on second and fourth Tuesdays of each month.

CIVIL ENGINEERS' SOCIETY OF ST. PAUL. Sec.: G. S. Edmondstone. Regular meetings on second Monday of each month.

ENGINEERING ASSOCIATION OF THE SOUTH. Sec.: Robt. L. Lund, 2102 Hayes St., Nashville, Tenn. Regular meetings on second Thursday of each month at the Berry Block.

ENGINEERS' CLUB OF CHICAGO. Sec.: B. W. Thurtell. 1223 New York Life Building. Regular meetings on first and third Tuesdays of each month.

ENGINEERS' CLUB OF CINCINNATI. Sec.: J. F. Wilson, P. O. Box 333. Regular meetings on third Thursday of each month.

ENGINEERS' CLUB OF COLUMBUS (OHIO). Sec.: H. M. Gates, 12½ North High St. Regular meetings on third Saturdays of each month.

ENGINEERS' CLUB OF MINNEAPOLIS. Sec.: Edw. P. Burch, 1210 Guaranty Bldg. Regular meetings on third Monday of each month.

ENGINEERS' CLUB OF PHILADELPHIA. Sec.: J. O. Clarke, 1122 Girard Street. Regular meetings on first and third Saturdays of each month.

ENGINEERS' CLUB OF ST. LOUIS. Sec.: H. J. Pfeifer, 920 Rialto Bldg. Regular meetings on first and third Wednesdays of each month.

ENGINEERS' SOCIETY OF WESTERN NEW YORK.. Sec.: L. W. Eighmy, 13 City Hall, Buffalo. Regular meetings, first Tuesday of each month.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA. Sec.: Chas. W. Ridinger, 410 Penn Ave., Pittsburg. Regular meetings on third Tuesday of each month.

FRANKLIN INSTITUTE. Sec.: Dr. Wm. H. Wahl, 15 South 7th St., Philadelphia. General meetings on third Wednesday of each month. Regular monthly meetings of the various sections on other days.

INTERNATIONAL ASSOCIATION OF MUNICIPAL ELECTRICIANS. Sec.: Frank P. Foster, Corning, N. Y. Meeting, September, Atlantic City, N. J.

IOWA RAILWAY CLUB. Sec.: P. B. Vermillion, Des Moines, Iowa. Regular meetings on third Tuesday of each month.

LOUISIANA ENGINEERING SOCIETY. Sec.: G. W. Lawes, 806 Gravier St., New Orleans. Regular meetings on second Mondays.

MASTER CAR BUILDERS' ASSOCIATION. Sec.: J. W. Taylor, 667 Rookery, Chicago. Meeting, June 17, etc. Mackinac Island, Mich.

MODERN SCIENCE CLUB. Sec.: R. Henderson, 302 Livingston St., Brooklyn. Meetings every Tuesday.

MONTANA SOCIETY OF ENGINEERS. Sec.: Richard R. Vail, Butte, Mont. Regular meetings on second Saturday in each month.

NATIONAL ELECTRIC LIGHT ASSOCIATION. Sec.: James B. Cahoon, 136 Liberty St., New York. Meeting, May 26-28, Chicago.

NEW ENGLAND RAILROAD CLUB. Sec.: Edw. L. Janes, Back Bay P. O., Boston. Regular meetings, second Tuesday in each month at Pierce Hall, Copley Square.

NEW YORK ELECTRICAL SOCIETY. Sec.: Geo. H. Guy, 114 Liberty St., New York. Meetings monthly, on different Wednesdays.

NEW YORK RAILROAD CLUB. Sec.: F. M. Whyte, Grand Central Station, N. Y. City. Regular meetings on third Friday of each month except June, July and August, at Carnegie Hall, 154 W. 57th St., New York.

NORTH-WEST RAILWAY CLUB. Sec.: T. W. Flannagan, Minneapolis, Minn. Regular meetings on first Tuesday after second Monday of each month, alternating between Minneapolis and St. Paul.

PACIFIC COAST RAILWAY CLUB. Sec.: C. C. Borton, West Oakland, Cal. Regular meetings on third Saturday of each month at different cities.

PACIFIC NORTHWEST SOCIETY OF ENGINEERS. Sec.: G. F. Cotterill, Seattle, Wash. Meetings monthly in Chamber of Commerce rooms, Seattle.

RAILWAY CLUB OF PITTSBURG. Sec.: J. D. Conway, P. & L. E. R. R., Pittsburg, Pa. Regular meetings on fourth Friday of each month at Hotel Henry.

RAILWAY SIGNALING CLUB. Sec.: B. B. Adams, 83 Fulton St., New York. Regular meetings on second Tuesday of January, March, May, Sept. and Nov. Annual meeting, Nov. 10, at Detroit.

RICHMOND RAILROAD CLUB. Sec.: F. O. Robinson, 8th & Main Sts., Richmond, Va. Regular meetings on second Thursdays.

ROADMASTERS' AND MAINTENANCE OF WAY ASSOCIATION. Sec.: Chas. McEniry, Cedar Rapids, Iowa. Annual meetng, Oct. 13, 14 and 15, at Kansas City, Mo.

ROCKY MOUNTAIN RAILWAY CLUB. Sec.: J. E. Buell, 906 20th Ave., Denver. Regular meetings on first Saturday after the 15th of each month.

ST. LOUIS RAILWAY CLUB. Sec.: E. A. Chenery, Union Station, St. Louis. Regular meetings on second Friday of each month.

SOCIETY OF CHEMICAL INDUSTRY, NEW YORK SECTION. Sec.: H. Schweitzer, 40 Stone St. Meetings on third Friday after the first Monday of each month, at Chemists' Club, 108 W. 55th Street.

SOUTHERN AND SOUTHWESTERN RAILWAY CLUB. Sec.: W. A. Love, Atlanta, Ga. Regular meetings on third Thursday of Jan., April, Aug. and Nov.

TECHNICAL SOCIETY OF THE PACIFIC COAST. Sec.: Otto von Geldern, 31 Post St., San Francisco. Regular meetings on first Friday of each month.

TEXAS RAILWAY CLUB. Sec.: T. H. Osborne, Pine Bluff, Ark. Regular meetings on third Monday of April and September.

TRAVELING ENGINEERS' ASSOCIATION. Sec.: W. O. Thompson, Oswego, N. Y. Next meeting, Sept. 8, Chicago.

WESTERN RAILWAY CLUB. Sec.: Jos. W. Taylor, 667 Rookery, Chicago. Meetings on third Tuesday of each month, Auditorium Hotel, Chicago.

WESTERN SOCIETY OF ENGINEERS. Sec.: J. H. Warder, Monadnock Block, Chicago. Regular meetings on first Wednesday and extra meetings on third Wednesday of each month.

Personal.

—Dr. George A. Soper, the sanitary engineer, of New York, has visited Ithaca, at the instance of the State Board of Health, and has made recommendations, which the Ithaca Common Council has given him power to carry into effect, for stamping out the recent epidemic of typhoid fever at that place.

—Mr. E. S. Farwell has opened an office at 309 Broadway, New York, for the general practice of his profession as consulting engineer. He is prepared to inspect, test, or design steam power plants, and the heating and ventilating systems of mills and large buildings. Complete electrical plants will be a specialty. His experience as expert steam engineer with the International Paper Company since its organization has furnished exceptional opportunities for the investigation of the many problems peculiar to the paper industry.

—Mr. R. J. Gross, second vice president of the American Locomotive Company, has started on a trip around the world, in the interests of his company. He will visit Japan, Korea, Siam and China, and will then travel via the Trans-Siberian Railway

to Russia, and on his way home he will visit nearly every country in Europe. Everywhere his efforts will be directed to extending the market for American locomotives, and to establishing permanent business relations with his company. Mr. C. M. Muchnic, recently mechanical engineer of the Denver and Rio Grande system, and formerly connected with the Brooks Locomotive Works, accompanies Mr. Gross, as secretary.

—Prof. Frederic William Sanders has been appointed to the chair of economics, sociology and modern languages in the Thomas S. Clarkson Memorial School of Technology, at Potsdam, N. Y.

—Mr. C. C. Murray is now connected with the Railway Appliances Company, with headquarters at Pittsburg, giving his time more particularly to the sale of the Q and C pneumatic tools.

—Mr. J. D. Hurley and Mr. A. B. Holmes, formerly connected with the Standard Pneumatic Tool Co., are now associated with the Rand Drill Company in the "Imperial" pneumatic tool department.

—Mr. J. D. Keiley has been appointed assistant electrical engineer, and Mr. E. L. Broome assistant steam engineer of the New York Central and Hudson River Railroad, with offices in New York.

—Mr. Guy W. Buxton, who has been connected for some time with the New York office of the H. W. Johns-Manville Co., has been recently appointed auditor of that company, the branches of which are located in Milwaukee, Chicago, St. Louis, Pittsburg, Cleveland, New Orleans, Boston and Philadelphia.

—Mr. William J. Taylor, of the Taylor Iron and Steel Company, of Highbridge, N. J., died recently at his home in Bound Brook, N. J. He was well known in the iron trade and was a member of the Engineers' Club and other organizations.

—Mr. Charles S. Powell, who has been associated with the Westinghouse electric interests since 1893, and who, for the past six years, has been manager of the Cleveland office of the Westinghouse Electric & Mfg. Company, has changed the scene of his activities from the United States to Europe. He has been appointed assistant manager of the British Westinghouse Electric & Mfg. Company, Limited, and has already entered upon the duties of his new position. Mr. Powell, who was one of the most popular men in the electrical business in the United States, is bound to be equally well liked in Great Britain. His headquarters are in the Westinghouse Building, Norfolk Street, Strand, London, W. C.

—At a meeting of the Fritz Memorial Committee, held in New York, the announcement was made that the four national engineering societies have appointed the following as their representatives on the Board of Trustees of the Fritz Medal: American Society of Civil Engineers—J. James R. Croes, New York; Robert Moore; Alfred Noble, New York; Charles Warren Hunt, New York. American Institute of Mining Engineers—E. E. Olcott, New York; E. G. Spilsbury, New York; James Douglas, New York; Charles Kirchhoff, New York. American Society of Mechanical Engineers—Gaetano Lanza, Boston, Mass.; John E. Sweet, Syracuse, N. Y.; Robert W. Hunt, Chicago, Ill.; S. T. Wellman, Cleveland, Ohio. American Institute of Electrical Engineers—Arthur E. Kennelly, Cambridge, Mass.; Carl Hering, Philadelphia, Pa.; Charles P. Steinmetz, Schenectady; Charles F. Scott, Pittsburgh, Pa. A preliminary organization of the Board of Trustees was effected and a committee was appointed to prepare the way for a permanent organization.

Industrial Notes.

—The exhibition, which is to open at Rheims, France, on May 15, 1903, will contain an important colonial subdivision. A special pavilion is reserved for those European products intended to be exported to the colonies. All applications for information should be directed to the "Administration de l'Exposition," at Rheims.

—The Baldwin Locomotive Works has recently offered to present to the Railway School of Sibley College, Cornell University, a laboratory locomotive of the Vauclain-deGlehn type, especially built to plans to be agreed upon by the Baldwin Locomotive Works and Prof. H. Wade Hibbard. The gift will not be consummated until a building and a testing machine are provided for. The locomotive will be a 4-cylinder balanced compound like the engine built for the Plant System, but with four truck wheels and four driving wheels. The

boiler will be designed to carry up to 300 pounds gauge pressure. When the locomotive is run at this pressure the entire weight of the locomotive can be thrown upon the driving wheels by means of a pneumatic cylinder at the rear connected to an anchor in the foundation. When this traction increaser is not used the engine will run at 200 pounds gauge pressure. It is intended to be very easily convertible into a perfectly balanced two cylinder simple engine by the removal of the two high pressure cylinder bushings and a change in the valves. The details of the engine have not as yet been worked out, but are being figured. No work at all has as yet been done on the designing of a testing machine, this awaiting the development of the design of the locomotive, its weight, power, wheel base, etc.

—The Diamond Drill & Machine Co. of Birdsboro, Pa., ran the initial heat of their new steel casting plant on March 7 without a single hitch or blunder; every pound of melted iron was poured into castings, and every casting came out perfect, with not a flaw or defect of any character in any single casting. They expect to run at least one heat a day every day continuously from now on, and are therefore in a position to make immediate and prompt delivery of steel castings. Considering the numerous difficulties encountered, in having their entire foundry destroyed in June, 1902, in which they lost valuable patents, the Diamond Drill & Machine Co., have just cause for congratulation upon the promptness with which they are at present able to supply their steel castings, as well as upon the demonstrated quality of their product.

—The Brown Corliss Engine Co. have increased their capital from $1,000,000 to $1,200,000, in order to have sufficient working capital to handle the great amount of large work on hand and in view.

—For the greater convenience of their numerous customers and to better care for the continued increase of business in New York and vicinity the Weston Electrical Instrument Co., of Waverly Park, Newark, N. J., have opened a New York office at 74 Cortlandt Street. This office will be under the management of Mr. Caxton Brown, who has a theoretical as well as a practical knowledge of the different instruments manufactured by the Weston company and their particular adaptabilities. This will enable any purchaser or any person visiting or doing business in New York who may wish to make inquiries relative to electrical measuring instruments, to come in direct contact with a man who is properly qualified to answer such inquiries. There will be a show room in connection with the New York office in which will be exhibited the different types of Weston instruments and their special advantages, as well as the individual parts which make up the instruments. Besides being a great convenience to customers, the New York office will eliminate much correspondence in the nature of inquiries, thus reducing the time of delivery of orders. A general impression has prevailed that the Weston Electrical Instrument Co., only make voltmeters and ammeters, which is not the case. Having what are credited with being the largest and best equipped works in the world for the production of electrical measuring instruments of all kinds, the company are particularly fitted to turn out work of any special character, in which the highest excellence of mechanical and electrical work and design are the important features. They have in fact been turning out a large amount of special laboratory apparatus for several years past and are now prepared to make standard cells, standard resistances, galvanometers, and the highest grade of special bridge work, speed indicators, etc. The Weston Electrical Instrument Co. extend a cordial invitation to all interested in the subject of electrical measurements to make use of their New York office, either for the purpose of inquiry on the technical points involved or for the prospective purchasing of instruments.

—The offer of the Graton & Knight Mfg. Co., of Worcester, Mass., to send, free of charge, one of their superior oak tanned belts to any manufacturer who would like to test it, is attracting a good deal of favorable attention. The reputation of this fine old house is a guarantee of the excellence of their belting, and that they will in every minutest respect do exactly as they agree.

—It may be of interest to our readers to know that The General Pneumatic Tool Co. recently incorporated, is a re-organization

of the business of the machinery department of the Havana Bridge Works, of Montour Falls, N. Y., which has been engaged for some years in the production and sale of improved pneumatic tools. The new corporation will manufacture pneumatic tools, compression riveting machines, pneumatic motor hoists, air compressors, cranes, etc. Extensive improvements in the manufacturing plant have already been made, and an additional building will be erected for a store and engine house, early in the spring. A portion of the new machinery is already in operation, but there are yet to be purchased screw machines, turret lathes, shapers, universal grinders, gear cutters, milling machines, and engine lathes. The tools of this company have received very gratifying recognition, and orders for compression riveting machines, pneumatic hammers, and pneumatic motor hoists, covering the company's capacity for several months, are already booked. Several new types of compression riveting machines have recently been brought out, in addition to those which have been on sale for several years. When all these tools are ready for the market, they will constitute one of the most complete lines of pneumatic machinery handled by any concern in the business.

—The Passaic Rolling Mill Company has been merged with the Passaic Steel Company, the latter company having taken over the entire capital stock of the Passaic Rolling Mill Company in exchange for its own shares. The Passaic Steel Company will continue the business of the Passaic Rolling Mill Company, assuming all of its liabilities and collecting all its assets.

—The Allis-Chalmers Co. will, on May 1st, 1903, remove their general offices from their present location in the Home Insurance Bldg. to the New York Life Bldg., corner of Monroe and La Salle streets, Chicago. This move is only another indication of the progressive spirit which prevails in the management of this strong industrial concern. To give a fair idea of the scope of the business enjoyed by the Allis-Chalmers Co., it may be mentioned that during the past two months orders for either engines, mining machinery, rock-crushing machinery, saw-mill machinery, or flour-mill machinery were booked from every state in the Union, besides the following outside countries: England, South Africa, Mexico, Canada, Chile, Central America, Brazil, West Australia, Turkey, Finland, Yukon Territory, Belgium, British Columbia, Bolivia, Hawaiian Islands, Peru, Alaska, China, and the Philippine Islands.

—The Nernst Lamp Company, of Pittsburgh, having secured patent and selling rights in Canada, are now making arrangements for establishing a factory in the Dominion for the manufacture of their product. This move is not only necessary in order to conform with the Canadian laws of commerce, but is also advisable in order to meet the rapidly increasing demands for this lamp.

—The Philadelphia Pneumatic Tool Co. has arranged to double the size of its offices in New York by renting additional room in the Singer Building, corner of Broadway and Liberty Street. This is made necessary by the greatly increasing business of this company in and around New York City. An electrically-driven air compressor and a complete plant for testing and exhibiting pneumatic tools of all kinds in operation will be installed. The New York offices will continue under the management of Mr. W. A. Battey, assisted by Mr. James H. Beaubien. Orders have been recently received by the Philadelphia Pneumatic Tool Co. for complete equipments of pneumatic tools for the National Railroad of Mexico and for the Interoceanic Railroad of Mexico. In two days last week this company shipped Keller rotary drills to the amount of over $10,000.

—Probably the most important contract for series-alternating equipment that has been awarded within the United States, was recently let by the City of Columbus, Ohio, to the Western Electric Company, of Chicago. This equipment comprises 1,500 series-alternating arc lamps complete, and is to be arranged in twenty 75-light circuits. The contract includes transformers, regulators, and the entire switchboard for the new municipal plant. The most thorough comparison was made between various equipments offered, and it was only after the installation of sample 25-light equipments furnished by several of the competing manufacturers that the contract was awarded. The Western Electric Company have a

most thorough, complete, and reliable series-alternating equipment, and are making installations rapidly throughout the country.

—Recent changes in the personnel of the management of the American Tool Works Co., of Cincinnati, have placed the management of the business in the following hands: Mr. Franklin Alter, president; Mr. Henry Luers, secretary and treasurer; Mr. J. B. Doan, general manager; Mr. A. E. Robinson, general superintendent. The month of February resulted in next to the largest month's business in the history of the company. The plant is exceptionally busy in all departments, and the outlook for future business is very bright. Extensive alterations and improvements are now being made, adapted to the company's increasing business. They have just brought out several new tools, embodying the very latest ideas in machine tool construction, and are much gratified at the success attending their introduction.

—The Chicago Pneumatic Tool Company, of Chicago, Ill., report the business prospects in their line decidedly encouraging and state that orders for air compressors and pneumatic machinery of every description continue to pour in with gratifying regularity, not only from all portions of the United States, but from almost every corner of the civilized world, taxing the facilities of their various plants to the utmost to adequately fulfill requirements and indicating clearly the strong hold which their machines have gained in the favor of mechanics everywhere. The business on the Pacific Coast has shown such an astonishing increase that they have decided to appoint Mr. Henry Engels, who has been prominent in the pneumatic tool business for a number of years, as their Western general sales agent on the Coast. Mr. Engels will have his headquarters with Messrs. Eccles & Smith, 91 Fremont Street, San Francisco, Cal., and all Pacific Coast business will be promptly and properly taken care of from this point. Messrs. Eccles & Smith still continue in their capacity as general agents of the company, and in conjunction with Mr. Engels, form a combination which will undoubtedly result to the mutual benefit of both the Chicago Pneumatic Tool Company and their numerous patrons.

—The New York Continental Jewell Filtration Co. have recently received orders from the Khedive of Egypt to install a system of Jewell gravity filtration for the royal palaces at Mantaya, near Alexandria; from Cornell University for a water-purifying plant; from the Columbus Water Works Co., Columbus, Ga., for a Jewell gravity filter plant of 2,000,000 gallons daily capacity for the city water supply; and for water-purifying plants from the Royal Hungarian Railroad, Klausenberg, Hungary; John J. Campbell, Philadelphia; and the Mutual Life Ins. Co., Cape Town, South Africa.

—The Electrical Engineering course at Union College, Schenectady, N. Y., has been reorganized under the immediate direction and supervision of Prof. Charles P. Steinmetz, the head electrical expert engineer of the General Electric Co., the largest electrical manufacturing company in the world. The conditions here for an electrical engineering school are unusually favorable, and we may say superior to any in the country, due to the old and well-established reputation of the college in engineering education, and the proximity and favorable disposition of the General Electric Co. In the works of the General Electric Co. the student is afforded chances to see and familiarize himself with apparatus and receive information which no other electrical engineering school can offer. Again, in the works of the General Electric Co., which are open to students, Union College has an electrical laboratory vastly greater than the electrical laboratories of all the colleges of the world combined. The complete course will be published shortly in the University catalogue, so it may be sufficient here to say that it will give a thorough grounding in the fundamental principles and their application to all branches of electrical engineering, such as will enable the graduate rapidly to acquire the practical experience necessary to electrical engineering success. A post-graduate course in electrical engineering has been established, which will give advanced instruction, comprising many subjects, which, while of fundamental importance in the modern development of electrical engineering, are not taught by any college, and even hardly published yet. It is such knowledge which establishes engineering reputations.

NEW CATALOGUES AND TRADE PUBLICATIONS

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine when you write.

Asbestos.

Catalogue, with illustrations, descriptions and prices of asbestos materials for a great variety of purposes, notably fireproofing and heat-insulating, and combined with magnesia for steam-pipe and boiler coverings. 7 by 5 in.; pp. 30. C. W. Trainer Mfg. Co., Boston, Mass.

Brass and Iron Goods.

Cloth-bound book, with illustrations, descriptions and price lists of brass and iron goods and pipe and pipe fittings for steam, water and gas, such as valves, cocks, gauges, steam traps, lubricators, etc.; metals, bells, gongs and bell fittings. 7 by 10 in.; pp. 300. Also, illustrated catalogue and price list of pumping and hydraulic machinery for every variety of service. 6½ by 10 in.; pp. 105. W. T. Garratt & Co., San Francisco.

Belt Dressing.

Cloth-bound booklet entitled "Cling-Surface and Belt Management," by John E. Powers, M. A., devoted to an account of Cling-Surface, an application for belting which causes the belt to cling to its pulley without sticking, and a general discussion of belt management, with illustrations of remarkably slack belts which have been treated with Cling-Surface. 7¼ by 4¾ in.; pp. 72. Cling-Surface Mfg. Co., Buffalo.

Carbonizing Coating.

Pamphlet entitled "Hitch Your Wagon to a Star," containing a discussion of the merits of various protective paints and coatings for iron and steel, and, particularly, of Carbonizing Coating, with illustrations of many buildings, bridges and other structures to which it has been successfully applied. 11 by 8 in.; pp. 27. Also, small folder, devoted to Carbonizing Coating. Goheen Manufacturing Co., Canton, O.

Cement Machinery.

Catalogue No. 15, sixth edition, with illustrations and descriptions of rotary kilns, rock and ore breakers, screens, crushing, grinding and pulverizing machines, elevating and conveying machinery, and other kinds of machinery for the modern manufacture of Portland cement. 9 by 6 in.; pp. 72. Allis-Chalmers Co., Chicago.

Drawing Materials.

Catalogue for 1903, 31st edition, with illustrations, descriptions and prices of all kinds of drawing materials and instruments, mathematical instruments and surveying instruments, and useful information and data. 9 by 5½ in.; pp. 491. Keuffel & Esser Co., New York.

Dynamos.

Booklet No. 31, with illustrations and descriptions of direct-current generators of various sizes and types, built for steady and economical service. 6¼ by 3½ in.; pp. 8. Northern Electrical Mfg. Co., Madison, Wis.

Electric Hoists.

Catalogue No. 0225, with illustrations and descriptions of electric hoists for manila or wire rope, in many sizes and for a great variety of purposes. 9¼ by 6¾ in.; pp. 16. Also, pamphlet No. 0228, a booklet devoted to electric hoists. C. W. Hunt Co., West New Brighton, Staten Island, N. Y.

Elevators.

Pamphlet, with illustrations and descriptions of direct-acting hydraulic plunger elevators, for both passenger and freight service, some of which have over 200 feet travel and speeds of from 500 to 600 feet per minute. Also, illustrations of buildings where these elevators are installed. 9 by 4 in.; pp. 15. Plunger Elevator Co., Worcester, Mass.

Finished Castings.

Folder, with illustrations and descriptions of finished castings, which look like machined pieces and are all ready to use. 11 by 8½ in.; pp. 4. H. H. Franklin Mfg. Co., Syracuse, N. Y.

Fire-Extinguishing Supplies.

Cloth-bound catalogue, with illustrations, descriptions and prices of wrought, cast-iron and brass pipe, fitings for steam, water and gas, automatic sprinkler hydrant systems, steam and hot water heating, boiler and engine connections, pumps, hydrants and Grinnell automatic sprinklers. 7½ by 5½ in.; pp. 384. General Fire Extinguisher Co., Providence, R. I.

Gasoline Engines.

Catalogue No. 17, with descriptions and illustrations of gas and gasoline stationary, portable, hoisting and pumping engines, geared base pumpers, mine locomotives and air compressors, in various types and sizes, and for many kinds of service. 6 by 9 in.; pp. 72. Weber Gas & Gasoline Engine Co., Kansas City, Mo.

Graphite.

"Graphite," volume v, number 4, a publication issued in the interest of Dixon's graphite productions, and for the purpose of establishing a better understanding in regard to the different forms of graphite and their respective uses. 11¾ by 9 in.; pp. 8. Joseph Dixon Crucible Co., Jersey City, N. J.

"Hydro-Carbon" System.

Pamphlet, with description of the "Hydro-Carbon" system for boiler furnaces, which increases power, saves fuel and prevents smoke by supplying heated air and hydrogen gas (from dissociated steam) to the fire chamber in special ways. Also, illustrations of stationary and marine plants where this system is in use, and testimonials. 6 by 9½ in.; pp. 32. Steam Boiler Equipment Co. of N. Y., Inc., 20 W. Houston St., New York.

Jacks.

Catalogue D, with illustrations, descriptions and prices of Barrett track jacks, automatic lowering jacks, car and car-box jacks, differential screw jacks, oil-well jacks, pipe-forcing jacks, automobile jacks, motor-armature lifts, and traversing jack bases. 8¼ by 5¾ in.; pp. 48. The Duff Manufacturing Co., Pittsburg.

Locomotives.

"Record of Recent Construction," No. 40, containing a reprint of a paper by W. J. McCarroll, read before the Traveling Engineers' Association, on the "Proper Handling of Compound Locomotives," with illustrations. 6 by 9 in.; pp. 16. Baldwin Locomotive Works, Philadelphia.

Machine Tools.

Catalogue, with descriptions and half-tone illustrations of hollow-hexagon and other styles of turret lathes, vertical turret machines, turret screw machines, valve-milling machines, automatic boring and tapping machines, key lathes, cock grinders, cutting-off machines, boring machines and other kinds of high-grade machine tools, and their attachments. 9 by 6 in.; pp. 59. The Warner & Swasey Co., Cleveland.

Mining Machinery.

Catalogue No. 15, a very large, cloth-bound book, with illustrations, descriptions and price lists of engines, boilers and feed-water heaters; hoisting engines; pumps, water wheels and hydraulic machinery; assayers' supplies; electrical machinery; iron and wood-working machinery; tools and other kinds of mining, milling and smelting machinery and supplies. Also, ready reference tables and useful information, and index. 10½ by 7½ in.; pp. 891. The Mine and Smelter Supply Co., Denver, Colo.

Oil Engines.

A pamphlet, with illustrated descriptions of the Secor oil engine, which uses kerosene oil, and Secor automatic oil-electric machines, in which oil engine and dynamo are combined in a self-contained unit. 9 by 6 in.; pp. 26. The General Power Co., New York.

Pneumatic Tools.

Catalogue, with illustrations and descriptions of pneumatic hammers, holder-on, rotary drills, riveting machines, foundry rammers, and other Keller pneumatic tools and their aplications. 6 by 9¼ in.; pp. 31. Philadelphia Pneumatic Tool Co., Philadelphia.

Punches and Shears.

Catalogue No. 5, with illustrations and descriptions of Werner's patent portable punching and shearing machoines for hand power, and Johns patent punching and shearing machines for belt power, all made of wrought iron and steel; and also adjustable roller trestles. 6¾ by 10½ in.; pp. 56. Henry Pels & Co., 66-68 Broad St., New York.

Railway.

Pamphlet entitled "Modernizing a Trunk Line," being a story of the permanent improvements on the Lackawanna Railroad since 1899, reprinted from the *Railroad Gazette*, with illustrations of bridges, stations and other work. 5 by 7 in.; pp. 30. Delaware, Lackawanna & Western Railroad Co., New York.

Rolling Doors.

Large pamphlet, with descriptions and illustrations of steel rolling doors, shutters and partitions for freight houses, round houses, warehouses, piers, shops, car sheds, factories, dry kilns, office buildings, stores, schools, churches, elevator shafts, and wherever fire protection and convenience are considered. 7¾ by 11 in.; pp. 13. The Columbus Steel Rolling Shutter Co., Columbus, Ohio.

Shaper.

Circular, with illustrated description of a vertical draw stroke shaper especially adapted for machining such work as cannot readily be handled on an ordinary planer or the regular type of shaper, and wherever it is necessary to remove heavy chips from the toughest metals. 9 by 6 in.; pp. 6. Colburn Machine Tool Co., Franklin, Pa.

Ship Log.

Pamphlet, with illustrated description of a log for indicating and recording the speed of vessels. A tube projects through the bottom of the ship, and the pressure due to the speed causes the water in the tube to rise to a height proportional to the speed of the vessel. Suitable floats in the tube are directly connected with the registering mechanism. 7½ by 5 in.; pp. 21. Also, pamphlet with testimonials. Nicholson Ship Log Co., Cleveland.

Steam Engines.

Booklet, with illustrations and descriptions of automatic steam engines of various types: center-crank horizontal, side-crank horizontal, center-crank upright, marine-type upright. 3½ by 6½ in.; pp. 12. The Buffalo Forge Co., Buffalo, N. Y.

Supplies.

Catalogue No. 14, bound in flexible cloth, with illustrations, descriptions and prices of general supplies for steam railroads, electric railways, contractors, bridge builders, stone quarries, mines, blacksmiths, saw mills, paper mills, flour mills, cotton mills, elevators, electric-light plants and water works. 9½ by 7 in.; pp. 505. H. Channon Company, Chicago.

Time Register.

Booklet, with illustrations and description of a clock for registering workmen's time by white lines drawn on black paper. 6½ by 3½ in.; pp. 4. Hawley Time Register Co., Syracuse, N. Y.

Tools.

The 1903 edition of this well-known catalogue, containing illustrated descriptions and useful information and data of milling machines, grinding machines, automatic gear-cutting machines, screw machines, cutters, accurate test tools, machinists' tools and many other kinds of fine machine tools and small tools. 5¾ by 3¾ in.; pp. 458. Brown & Sharpe Mfg. Co., Providence, R. I.

IMPROVED MACHINERY

New Processes and New Appliances

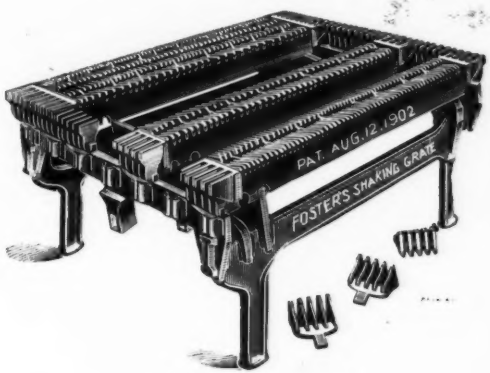
The matter here published is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

Foster Shaking Grates.

ALMOST any grate will hold the fire, but every grate will not remove the ashes. The Foster shaking grate performs both of these functions, and has other advantages that most grates do not have, and some that no others have.

It can be placed in the ash-pit without changing the fire-box or defacing the boiler front. It can also be removed with as little trouble and expense, but there is very little occasion for removing a Foster grate, as it requires less repairing and is more durable than any other.

The Foster shaking grate has a direct alternate lateral movement, with no lost motion. There are two shakers, one for each half of the grate-bars, and when too brisk a fire is not required, only one set of bars need be used. The bars are always level. They may be left in any position, and there are no fingers projecting into the fire to burn off. The Foster is a perfect substitute for a stationary bar, and yet has none of the disadvantages of the latter. If used as a stationary bar, the hoe and slice bar can be used when drawing and banking the fires.



FOSTER SHAKING GRATE.

The grate header is so constructed that it cannot warp or burn out, as its supporting frame is underneath, away from the sides of the fire-box. The grate rests on legs and is entirely independent of furnace walls and boiler front. There are no bearer bars to be adjusted and to fill up the ash-pit.

The Foster grate has sixty per cent. air space, which adds greatly to its efficiency, and it is on this account especially adapted to soft coal, as well as to hard coal, and is an effective smoke preventer.

It is a very easy job to set up the Foster grate, and it does not require an expert to do it. The bars are all alike and interchangeable, and there are no bolts, nuts, screws, rivets, rollers or tilting irons to drop out or become displaced and cause trouble.

This grate is made in many sizes, square, oblong or round, and will burn all kinds of fuel. Further information concerning it will be gladly furnished, on request, by the manufacturers, the F. W. Foster Mfg. Co., of 8 Portland St., Boston.

Plastic Metallic Packing.

PLASTIC metallic packing, which, in the accompanying illustration, is shown ready for service in a stuffing box, comes from its place of manufacture in a plastic form which can be made to take any desired shape.

Whereas soft packing and other metallic packings are furnished in definite sizes or sets to fit rods or stuffing boxes of various diameters and lengths, plastic metallic packing can be made to fit anything, and adapts itself easily to all requirements.

Soft packing is affected by temperature, and under high steam pressure lasts but a short time, while plastic metallic packing is not affected by extreme heat or cold, and is just as durable as any other working part of the engine.

PLASTIC METALLIC PACKING.

Soft packing often requires extreme pressure to make a good joint around a piston rod, and is thus apt to score or flute the rod, whereas plastic metallic packing needs no undue pressure, as it automatically makes a good fit, and being also non-frictional, it cannot injure the piston rod.

All other metallic packings usually require a new rod in order to attain their highest efficiency, but plastic metallic packing gives as good service around an old rod as around a new one.

Plastic metallic packing is the only metallic packing on the market which may be used satisfactorily on steam hammers. It is also very well adapted to all piston rods, air compressors, locomotive air pumps, throttle valves, Corliss valves and valve stems. It can be used in any stuffing box, requiring no changes of any kind, and it may be applied without disconnecting the rod.

Any further information regarding this useful packing will be gladly furnished by the manufacturers, The Hileman-James Co., of Pittsburg.

Mietz & Weiss Kerosene Engine.

OWING to the ease with which kerosene may be obtained in any quarter of the globe, the demand for engines which use such fuel is increasing every day. But in order that an engine may have a widespread application, it must be so constructed that its action will be automatic and that it will require the minimum of attention, as it will necessarily go into the hands of persons not familiar with the operation of machinery.

In the design of the Mietz & Weiss engine, the responsibility for the performance of its duty has been placed upon the mechanism, rather than upon the user. In all the engines of these makers, the general construction is of the highest class, and embodies all the latest improvements. They are adapted to the use of gases, either natural or artificial, and of kerosene.

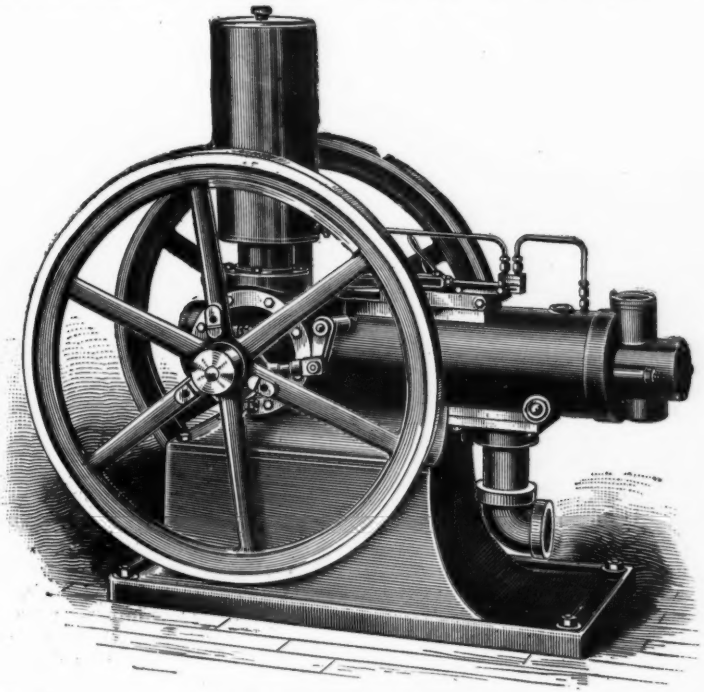
The working method of the Mietz & Weiss engines is the same for all of these fuels, their construction differing only in the mechanism for injecting the fuel into the cylinder. The engine at full power receives an impulse at each turn of the crank shaft, that is, the air and fuel injection, the compression and burning of the mixture, and the expulsion of the exhaust, are all performed at a single revolution, by a most direct and simple method.

The inclosure of the crank shaft, besides excluding dust and dirt from the mechanism of the engine, possesses many other advantages, among which may be mentioned: Rigidity of the crank-shaft bearings; perfect lubrication; the prevention of disagreeable odors due to slight leakages past the piston, which are often noticeable in open-cylinder engines, but which are entirely done away with in the Mietz & Weiss engines by passing a charge of pure air through the crank chamber at every revolution; cleanli-

ness; no throwing of oil by the crank; the elimination of danger from exposed crank shafts; silent and smooth running.

The governor is extremely simple and effective. It is arranged to operate from the main shaft direct without any belting or extra shaft, graduating the charge from zero to full load. It is well known that this method of regulation affords a much steadier speed than the old hit-and-miss principle. There is probably no machine which calls for a closer regulation than the electric generator, and the application of the Mietz & Weiss kerosene engine to electric work, either belted or direct coupled to generator, for lighting, charging storage batteries and telephone and telegraph installations, has been very successful, equaling the modern high-speed steam engine in furnishing a current of practically constant voltage.

It is a recognized fact that while the design and the execution of the mechanism may be faultless, yet with an imperfect igniting arrangement the engine is worthless. The tube igniter of the Mietz & Weiss gas engine is practically indestructible by heat. It can be replaced at a trifling cost in case of accidental breakage. No cleaning or renewal is necessary. The ignition in the kerosene engine, being effected by compression, is entirely automatic. Provision is made for a kerosene blue burner, furnished with each engine, to be used for a few minutes before starting. No slide valve, no electric igniter and no tube igniter are used,



MIETZ & WEISS KEROSENE ENGINE.

a very desirable feature, especially appreciated by woodworkers and others, on account of the inflammable nature of their products.

The Mietz & Weiss kerosene engine has a closed copper tank, or oil receiver, of a capacity for ten hours' run, firmly screwed to the cylinder. From this tank the kerosene is forced, by means of a simple pump, directly into the cylinder, and there vaporized and mixed with the air for combustion.

The lubrication is positive and automatic,

the oil for this purpose being forced by pressure to parts needing lubrication as long as the engine is in motion. The boxes at both ends of the connecting rod, as well as the main-shaft bearings, are made of the best phosphor-bronze bearing metal, with large wearing surfaces. The pressure in the crank chamber being alternately over and under atmosphere, the oil is forced up from the reservoir through the sight feeds, where the drops are visible and can be regulated. The ring-oilers for the main shaft are known as the best and most efficient for this purpose.

In the Mietz & Weiss universal pumping engine, either gas or kerosene may be used as fuel. A simple clutch is employed to throw the pump in and out of action, making the engine easy to start, and allowing it to be used for general power purposes as well as for pumping. The pump stroke is adjustable to meet varying requirements as to pressure and quantity of water, thus making this a universal pumping and power engine.

The Mietz & Weiss engines are very economical to run, plants in actual operation having consumed less than one-half cent's worth of kerosene per horse-power hour. They can be fitted to almost any kind of service, and if persons who are interested will apply to the manufacturer, Mr. August Mietz, of 128-138 Mott St., New York, he will recommend the size and style required, and will cheerfully furnish any further information that may be desired.

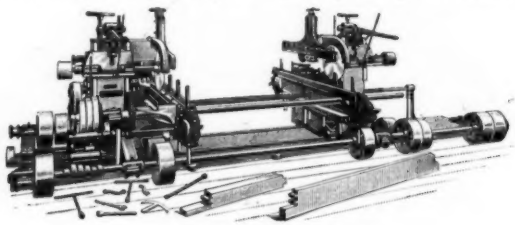
Automatic Double Car Tenoner.

IN bringing out the new tenoner shown in the illustration, it has been the aim of the manufacturers and patentees to make it as labor saving as possible, and as it is entirely automatic, all responsibility is taken off the operator in marking his stock. The machine cuts to exact lengths, and each piece comes from it accurately worked and with wonderful rapidity.

Limited space permits of only a brief exposition of its many features and mechanical improvements for performing its work to advantage, but special attention is called to the following points:

It will cut-off and tenon material from 10 inches to 9 feet long between shoulders, and will cut-off and tenon both ends of timber to 24 inches wide and 8 inches thick. By cutting-off the lengths on some other machine, dispensing with the saws on this, timbers 12 inches thick can be tenoned to advantage.

Saws 22 inches in diameter can be used, and operating in advance of the cutter



AUTOMATIC DOUBLE CAR TENONER.

heads, the burr raised by the saws is perfectly removed by the cutters, thus saving much valuable time. A special head is provided for making double tenons to 4 inches deep.

There are eight tenoning heads, two on each spindle, and each carrying two knives cutting tenons 6 inches long, so by using two heads on each spindle a tenon 12 inches long can be cut.

The machine is massive, perfectly built to stand hard work, and lots of it, and the adjustments are made quickly and accurately.

The makers, J. A. Fay & Egan Co., of No. 212 to No. 232 West Front street, Cincinnati, Ohio, will be glad to send to those interested prices, cuts of machine and full information, and will also send, charges prepaid, their large new combined 450-page catalogue, showing each and every machine they make, to those writing for it mentioning THE ENGINEERING MAGAZINE.